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VOL. CLIII.—No. 3971] LONDON: FRIDAY EVENING, FEBRUARY 19, 1932 [PRICE { WITH SUPPLEMENT } ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES.

Borough of Ilford and Borough OF BARKING.
ILFORD AND BARKING JOINT SEWERAGE COMMITTEE.
TRANSFORMER EQUIPMENT, &c.—CONTRACT No. 9B.

The above Authorities are prepared to receive TENDERS for the SUPPLY and ERECTION of TWO TRANSFORMERS of 300-kW capacity, together with all the necessary High-tension and Low-tension Switchgear and appurtenant works, to be erected on the site of the new Joint Sewage Pumping Station at Barking, Essex.

General conditions, specification, and form of Tender may be obtained at the office of the Engineers, Messrs. W. H. Radford and Son, Civil Engineers, Albion Chambers, King-street, Nottingham, on deposit of Two Guineas (cheque), which will be returned on receipt of a bona fide Tender.

The lowest or any Tender will not necessarily be accepted.

Sealed Tenders to be delivered to the undersigned on or before the first post on Thursday, March 10th, 1932, endorsed "Transformer Equipment."

By Order of the Joint Committee of the above Authorities,

ADAM PARTINGTON,
Clerk to the Committee.

Town Hall, Ilford,
15th February, 1932. 8162

City of Nottingham.

TENDERS are INVITED for ENGINEERING and LAUNDRY EQUIPMENT for WASH-HOUSE, &c., Main-street, Bulwell, Nottingham.

Specification and drawings may be obtained from Mr. T. Wallis Gordon, City Engineer and Surveyor, Guildhall, Nottingham, on payment of a deposit of £2.

Sealed Tenders are to be delivered to me not later than 6 p.m. on Thursday, 10th March, 1932.

The lowest or any Tender will not necessarily be accepted, and Tenders will only be accepted from persons paying the local standard rate of wages, &c.

W. J. BOARD,
Town Clerk.

Guildhall, Nottingham,
9th February, 1932. 8166

Lichfield Rural District COUNCIL.
TENDER FOR SEWAGE PUMPING STATIONS AND PUMPING PLANT.
ALREWAS SEWERAGE SCHEME.

TENDERS are INVITED for the FOLLOWING:—
CONTRACT 3.—TWO PUMPING STATIONS in Brick and Concrete.
CONTRACT 4.—Electrically Driven PUMPING PLANT (Three Pumps in one station and Two in the other), together with an Auxiliary Oil Engine and Automatic Float Controls.

Schedules can be obtained on or after the 29th February on application to Mr. C. E. Mays, Assoc. M. Inst. C.E., the Council's Engineer, Rural Council House, Lichfield, on receipt of a cheque for £2 2s., which will be returned on receipt of a bona fide Tender.

Tenders, endorsed "Tender for.....," must be forwarded to the Clerk to the Council not later than Thursday, 3rd March, 1932.

THOMAS MOSELEY,
Clerk to the Council.

Rural Council House,
Lichfield. 8167

London County Council.

TENDERS are INVITED for the REBUILDING and STRENGTHENING of the GRANITE PARAPET of the RIVER WALL in front of Grosvenor-road and Pimlico-gardens, the REBUILDING at a higher level of the GRANITE COPING and RAILINGS in front of Grosvenor-road, and consequent Alterations to the Footway Paving in Grosvenor-road and Pimlico-gardens.

Specification, form of Tender, &c., may be obtained on and after 22nd February, 1932, on application to the Chief Engineer, Old County Hall, Spring-gardens, S.W. 1, upon payment of £2 by crossed cheque or order, payable to the London County Council. (NOTE.—CASH WILL NOT BE ACCEPTED.) This amount will be returnable only if a bona fide Tender has been sent in and not subsequently withdrawn. Full particulars of the work may be obtained on personal application, and the contract documents may be inspected before payment of the fee.

Remittances by post should be addressed to the Chief Engineer, Old County Hall, Spring-gardens, S.W. 1. Personal inquiries at Room 2, No. 3, Warwick House-street, Cockspur-street, S.W. 1.

The contractors will be bound to observe the provisions of a fair wages clause, the terms of which are set out fully in the instructions for tender and form of contract and in "The London County Council Gazette."

No Tender received by the CLERK OF THE COUNCIL at County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 7th March, 1932, will be considered.

The Council does not bind itself to accept the LOWEST or any Tender. 8173

The County of London Electric SUPPLY CO., LTD.
BARKING POWER STATION EXTENSIONS, 1930.
TENDER FOR MAIN, AUXILIARY, AND MULTICORE CABLES, AND ACCESSORIES.

The County of London Electric Supply Company, Limited, are prepared to receive TENDERS for the SUPPLY, DELIVERY, and ERECTION at Barking Power Station of MAIN, AUXILIARY, and MULTICORE CABLES and ACCESSORIES.

Specifications for Main, Auxiliary, and Multicore Cables and Accessories may be obtained by manufacturers of cables from the offices of the Company by application on or after Monday, 22nd February, 1932, and on payment of a fee of £5 5s. for the first copy and £2 2s. for every subsequent copy. Sums paid for any number of copies up to three will be refunded on receipt of a bona fide Tender.

Sealed Tenders endorsed "Tender for Main, Auxiliary, and Multicore Cables and Accessories," must be delivered, addressed to THE CHAIRMAN, The County of London Electric Supply Co., Ltd., County House, 46-47, New Broad-street, London, E.C. 2, not later than Noon on Tuesday, 15th March, 1932.

The company do not bind themselves to accept the lowest or any Tender. 8174

The Manchester Steam Users' ASSOCIATION.

For the Prevention of Steam Boiler Explosions and for the Attainment of Economy in the Application of Steam, 20, QUAY-STREET, DEANSGATE, MANCHESTER.

Founded 1854 by SIR WILLIAM FAIRBAIRN.

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The Engineer

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Required, Electrical Engineer and MANAGER, for Aden Settlement Electricity Department, Aden, Arabia. Must be sound, practical Engineer with special experience in Repairs, Renewals, and Maintenance of High-speed Geared Turbines, Water-tube Boilers, Auxiliaries, &c., and conversant with High and Low-tension Distribution and Electrical Apparatus. Must be efficient, abstemious, responsible, and capable of taking full control.

Applicants should apply to the Chairman, Aden Settlement, stating age, married or single, when available, enclosing references and full particulars of experience from school to date, also enclosing recent photograph.

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For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge and co-operation is asked for.

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GENTLEMAN, Age 28-35, with Commercial ability and experience, is REQUIRED in a Managerial Capacity for Provincial Branch of important Concern. The commencing remuneration is reasonably substantial.

Future possibilities depend on the capabilities of the selected applicant.

Men whose business progress to date is outstanding should send fullest particulars, in confidence, to X.Y., c/o Robbins, Olivey and Lake, 218, Strand, London, W.C. 2. 8180 A

MANAGER for Well-established Forge and Engineering works in Sheffield. Preference given to applicant with travelling experience or business connection and willing to take up one thousand or more shares six or twelve months hence. State in full experience, &c., age and salary required.—Address, P2078, The Engineer Office. P2078 A

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PUBLIC NOTICES.

ROYAL SHOW

SOUTHAMPTON
July 5th to 9th, 1932.

EXHIBITION OF IMPLEMENTS, &c.

The Regulations and Forms of Application for Space are now ready.

Applications for space must be made by
MONDAY, MARCH 21ST, 1932.
ENTRIES for Silver Medal close March 1st.

Live Stock, Produce and Forestry entries close on MAY 20th; Flower Show on MAY 25th; Poultry and Butter Making Competitions on MAY 31st; Cider, Plantations, Home Nurseries, Orchards and Fruit Plantations on May 2nd.

T. B. TURNER, Secretary.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND,
16, Bedford Square, London, W.C. 1.

SITUATIONS OPEN (continued)

DRAUGHTSMAN and DESIGNER WANTED, with experience in Packeting and Carton-making Machinery.—Apply by letter only, stating age, experience and salary required, JOB DAY and SONS, Ltd., Engineers, Beeston Royds Works, Leeds. P2046 A

WE Shall be Glad to Receive APPLICATIONS for the POSITION of HEAD DRAUGHTSMAN in our Conveyor Dept. Applications, which should state age, experience, salary required, and enclose copies of three recent testimonials, to be received by Saturday, February 27th. The successful applicant will be required to subscribe to superannuation scheme.—Address, 8176, The Engineer Office. 8176 A

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The Engineer

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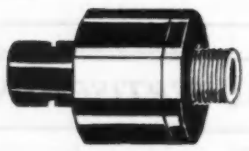

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P2013 I

THE UNDERMENTIONED DESIRES SUGAR MANUFACTURERS in G.B. and Germany to QUOTE for a COMPLETE MORDEN, capable of an output of One Ton daily, to be driven by a Crude Oil Engine. Specification and plans regarding Crushing and Manufacturing must reach me before the 15th April, 1932.
The MANAGING AGENT, Victory Mills, Victoria P.O., Champaran District (India). P2061 I

For continuation of Small Advertisements see pages 4 and 68.

NOTICE

To those having Factory Sites or Engineering Premises and Offices for disposal.

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A Seven-Day Journal

A Gift of a Propeller Tunnel.

A GIFT to the nation of a sum of £5000, sufficient to meet the entire cost of a tunnel to be installed at the National Physical Laboratory for research on problems relating to the design of ships' propellers, has been made by Sir James Lithgow. In a letter issued to the Press at the end of last week, in which he states that, as the Minister responsible for the Department of Scientific and Industrial Research, it had given him great pleasure to accept the gift, Mr. Stanley Baldwin discusses the value of the apparatus that will be set up. Pointing out first that with fewer ships being built all over the world it has become especially important that an increased percentage of what orders there are should be attracted to this country, the letter goes on to state that to achieve this purpose the experience and reputation for good workmanship enjoyed by British shipbuilders is not sufficient. The prospective purchaser now demands that these qualities should be combined with a keen appreciation of the latest results of scientific knowledge and research, and with a readiness to apply them. The nation owes a tank at Teddington to the far-sighted beneficence of Sir Alfred Yarrow, and the value of the work carried out in that tank cannot be accurately assessed. It can, however, be definitely stated that in the four years 1927–1930, 188 hull designs were tested and improvements in 114 of them were commended. Our competitors abroad had erected similar tanks. Certain problems of propeller design, however, cannot be studied in such tanks. Those problems require a propeller tunnel. No such apparatus exists at present in this country, although several have been built abroad in recent years. Sir James Lithgow's gift thus removes a serious handicap to shipbuilding research in this country. His action is striking evidence of the courage with which leading men in industry are facing the economic difficulties through which the nation is passing and of their faith in the future.

Waterloo Bridge.

IN a journal note in our issue of January 29th, we mentioned that the Improvements Committee of the London County Council would recommend that Waterloo Bridge should be rebuilt to accommodate six lines of traffic. Last Tuesday, the proposal was put before the Council and in spite of considerable opposition was adopted by a substantial majority. Of the objections put forward, the more serious were concerned with the cost involved. According to the Committee a new bridge could be constructed at an estimated expenditure of £1,295,000, but it was questioned whether this figure represented the total outlay. The construction of a new bridge will involve both the demolition of the old one and some alteration of the existing temporary bridge. The new bridge is to have fewer piers than the old, whereas the present temporary structure has the same number. Were the new bridge to be constructed without altering the temporary one, great inconvenience would be caused to river traffic, since the relative positions of the piers of the new and the temporary structure would not coincide. The belief was expressed that the work would take six years, and that for part of that time the Embankment would be closed to traffic while the old arch across it was being demolished. Some still advocate the reconditioning of the old bridge. Such a work could be concluded in eighteen months and would involve no dislocation of road and river traffic, besides being much less costly. The advocates of this proposal also point out that a bridge wide enough to take six lines of traffic would cause congestion at the point where the approach to the bridge joins the Strand. It is understood that the Minister of Transport is ready to make a grant of 60 per cent. of the cost of the construction of the new bridge.

The Economic Position of Shipping.

IN the annual report of the Chamber of Shipping of the United Kingdom, presented to the members at the annual meeting yesterday, February 18th, there is contained an interesting study of the present economic position of shipping. In spite of depreciation, sterling has been maintained as the international freight currency, but its fall has not been compensated for by the slight increase of freights. Tanker freights last year were the worst on record and passenger traffic declined sharply. British shipping, the report states, is highly efficient, nearly 50 per cent. of the vessels being under ten years of age. More than 40 per cent. of this category of world tonnage is British owned. Although British shipping is suffering as a result of the depression, that of other countries is in a worse case. Out of 12 million gross tons of shipping laid up in the world, representing 17 per cent. of the total tonnage, 3 million gross tons are laid up in the United Kingdom. The report considers that tonnage would not be in excess of demand had trade developed normally. It is pointed out, however, that, although the present population exceeds that of pre-war days by 10 per cent., trade was only 20 per cent. greater in 1928 and is at the present day probably no greater than in 1914, whilst world tonnage is now 50 per cent. greater than in that year. The report lays the blame for the surplus upon the reckless policy of foreign Governments in subsidising shipping, and considers that subsidies constitute the most serious international menace to the industry. The economic position compelled the curtailment of shipbuilding programmes, and tonnage under construction fell during last year from 2·3 million to 1·4 million gross tons, the greater part of the decrease occurring in British yards. Dealing with the relative proportions of steam, motor, and sailing tonnage, a decrease in the first category by 636,000 tons and in the last by 1,176,000 tons is reported, while motor tonnage increased by 1,335,000 tons.

Improvements on the L.N.E.R.

WORK has now been started on the widening of the Liverpool-street and Colchester main line on the London and North-Eastern Railway between Gidea Park and Shenfield. The scheme includes the improvement of about 6¼ miles of track and alterations to stations at Harold Wood, Brentwood, and Shenfield. When the work has been completed there will be four roads from Liverpool-street to the junction of the Southend lines near Shenfield. As a result of the improvement, there will be no interference between the suburban services in the district and the through express trains. A number of alterations to bridges are involved in the scheme. Two will be destroyed, three will be extended, one new one is to be built, and many others will have to be reconstructed. At the Brentwood cutting retaining walls will have to be built for a length of nearly 2 miles, with a height in places of 20ft. The carrying out of the work, it is stated, will involve a certain amount of delay to the train services to the affected district, but these delays will be kept to a minimum by retiming and rearranging the running of the trains. The improvement is to be effected in such a way that should electrification be decided upon in the future the change-over to the new form of traction will be easily made. The work will cost about £800,000, and provide employment for over 1000 men for two years.

Electrical Measuring Instruments.

A SPECIAL exhibition of electrical measuring instruments was opened at the Science Museum, South Kensington, on February 13th, and will remain on view until the middle of May. The Exhibition illustrates the evolution of electrical measuring instruments, from the discovery of the fundamental principles on which they are based, up to the present day, and is substantially the same as that arranged by the British Electrical and Allied Manufacturers' Association, and shown at the Albert Hall on the occasion of the Faraday centenary celebrations in September last. With a view to interesting the non-technical public, a series of simple demonstration experiments has been arranged to illustrate the various fundamental principles, and their application to electrical measurement. Demonstrations will be given daily, the apparatus in some cases being a replica of that used by the original discoverer of the principle. The Exhibition, which comprises about 250 items, includes many original instruments, such as Kelvin's reflecting galvanometer, a resistance coil used by Wheatstone, Joule's current balance, and the coil with which Maxwell determined the ohm. Among the interesting replicas are those of Oersted's compass, with which the magnetic effect of an electric current was first demonstrated, Ampère's electrodynamic apparatus, the apparatus with which Ohm discovered "Ohm's Law," and Sturgeon's electro-magnetic engine, which was the first machine to embody a commutator.

Copper Oxide Rectifiers.

A LEGAL decision of interest and importance to those associated with the electrical industry was recently given in the United States Circuit Court of Appeals in an infringement action involving the basic United States patent on the copper oxide rectifier which covers the principle of alternating-current rectification at the internal boundary between a copper plate and a layer of copper oxide formed directly on the plate. The invention is due to Dr. L. O. Grondahl, of the Union Switch and Signal Company, of Pennsylvania, and that company and its licensees, the Westinghouse Electric and Manufacturing Company, of Pittsburgh, were plaintiffs in the action, the defendants being the Kodel Electrical Manufacturing Company. In the original action in the lower Court it was held that certain vital claims of the Grondahl patent were valid and were infringed by the defendants, and the plaintiffs were granted an injunction with an account of profits and damages. During the original action and in the Appeal Court a large number of prior publications cited against the novelty of the invention were considered at great length, and while it was admitted that the rectification or detection of small alternating currents by devices involving point contact phenomena was well known prior to the date of the patent, none of those publications disclosed the broad idea of utilising a relatively large area at the internal boundary between a copper plate and a layer of cuprous oxide formed thereon. The Appeal Court confirmed the finding of the lower Court as regards infringement by the defendants, and that the claims in the patent covering the broad idea of rectification over a relatively wide area at the internal boundary between the copper and the copper oxide formed thereon were valid.

Agricultural and General Engineers.

IN a Journal note of December 25th we recorded the steps which led up to the appointment of Sir Gilbert Garnsey and Lord Plender to advise the board of Agricultural and General Engineers, Ltd., and in our following issue, January 1st, we outlined the terms of the inquiry to be made into the affairs of the company by these investigators. On Monday last, February 15th, the long-awaited report and accounts covering the year ended March 31st, 1931, were issued, together with a statement that on Monday last Sir Gilbert Garnsey was appointed receiver and manager of the company. The results of the working for the year ended March 31st last show a loss of £235,226 and a debit balance on the profit-and-loss account of £591,344. The trading results over the period under review were, the report states, very unsatisfactory. It may be recalled that on February 5th last Mr. G. E. Rowland, the former chairman, resigned his directorship of the company and of certain associated companies, while on February 11th Mr. G. D. Perks, the vice-chairman, and Messrs. H. Carlisle, L. W. Smith, and A. Leggett similarly resigned their directorships. Mr. J. E. S. Perkins, the director retiring by rotation, does not offer himself for re-election. The joint investigators, Lord Plender and Sir Gilbert Garnsey, have not yet had time to make their report. The present board, after considering carefully the resignations above referred to, came to the conclusion that the best course in the interests of the company was to request the bank to appoint a receiver to the company's undertaking. A general meeting is to be held on February 25th.

The New G.W.R. Cross-Channel Steamers.

THE new Great Western Railway Company's steamer "St. Andrew," which, together with her sister "St. David," is being constructed by Cammell, Laird and Co., Ltd., at Birkenhead, for the company's Fishguard cross-Channel service, is now approaching completion, and early this week the "St. Andrew" was inspected by guests of the railway company, prior to her being placed in commission. Each ship has a length of 335ft., a beam of 46ft. 6in., and a depth of 18ft. 9in., and is propelled by Parsons geared turbines, steam being raised in Babcock and Wilcox water-tube boilers. A feature of the design is the complete conformity with the recommendations of the International Convention for Safety of Life at Sea, and the ships are the first to be built for the Irish service with a special covered deck for motor cars. Accommodation is provided for 1000 passengers and the cargo space includes about 49,000 cubic feet of refrigerated space for perishable goods, which is kept at the appropriate temperature by electrically driven refrigerating plant.

Coal and Oil.

IN a discourse on Petroleum, which was delivered at the Royal Institution on Friday evening of last week, Sir John Cadman gave some interesting particulars with regard to the world's production of petroleum, and the utilisation of the world's fuel reserves. By the constant application of applied science, he said, the world's yearly production of petroleum had risen from 70,000 tons to nearly 200,000,000 tons in the relatively short space of seventy years. After referring to the increased use of petrol for land and marine work, future developments, which Sir John said offered prospects of absorbing scientific interest, were touched upon. No doubt a highly efficient oil-driven turbine would, he said, be perfected at some future date, while before long the high-speed compression ignition engine would rise to a position of great importance for land work, as the marine Diesel engine had already done at sea. Dealing more particularly with the scientific utilisation of our fuel reserves, Sir John pointed out that Great Britain regarded coal and oil-bearing countries as actual or potential sources of revenue. Such reserves must, he held, be regarded as capital assets, and they should impose the obligation to avoid waste by using each mineral in the most economical and scientific manner. The railway companies consumed annually 13,000,000 tons of coal, but oil-electric locomotives could do the work on 1,600,000 tons of oil. Economy in transport represented a reduction in the nation's cost of living, and conferred the ability to produce and sell at lower cost. If Great Britain, Sir John urged, adhered to a policy of coal utilisation for the sake of its mines, our industries might be still further handicapped. Despite the inroads oil might make, there would still remain, he thought, a wide field for coal. The construction of motor cars, compression ignition engines, and oil-electric locomotives would necessitate the consumption of large quantities of coal, with the additional benefit that we should sell not a raw material, but a finished product, representing the skill and science of many British industries.

The Erosion of Steam Turbine Blades.

By F. W. GARDNER, B.A., A.M. Inst. C.E.

No. III. (*conclusion*).*

Experimental Investigation.

In order to investigate the erosion problem under conditions more representative of those experienced in commercial service than had previously been attempted, an experimental apparatus was constructed, in which the arrangement of an actual turbine exhaust was reproduced. It consisted essentially of a spindle which could be rotated in a casing containing steam at high vacuum and charged with a spray of water drops which traversed the path of the blades. The only respect in which the conditions differed from practice was that the quantity of water producing erosion was increased, so that the action was greatly accelerated. The apparatus was originally constructed in 1925 and since that time extensive researches have been carried through.

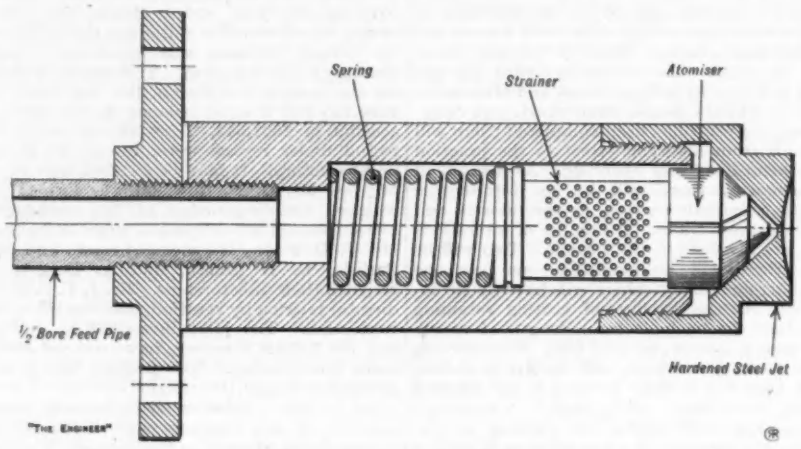


FIG. 14—"WHITE" OIL-FUEL BURNER JET

In its original form the equipment comprised a rotor on which was formed a disc which could be fitted with blades of any material that it was desired to test. The rotor was mounted in the casing of a centrifugal pump and direct-coupled to a high-speed turbine capable of running up to a speed of 10,000 r.p.m. The disc was 12in. in diameter and was designed to carry a single row of blades ¾in. wide and 4in. long. The diameter over the tips of the blades was thus 20in., corresponding to a speed of 870ft. per second at 10,000 r.p.m. Two banks of water jets were mounted in the casing on opposite sides near the horizontal centre line by means of which water could be squirted on to the blades. Each bank consisted of four jets, originally $^1/_{32}$in. in diameter and ¾in. distant from the blades, but later altered to $^1/_{16}$in. in diameter and ¼in. distant from the blades. The jets were arranged so as to point directly towards the blades and were spaced out radially, so as to impinge on the latter at diameters of 13in., 15¼in., 17½in. and 19¾in. respectively.

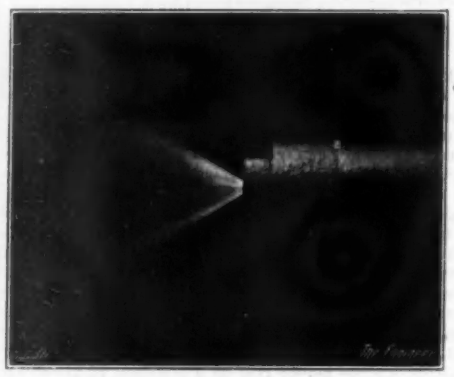


FIG. 15—WATER SPRAY FROM JET

Ingress of air was prevented by the provision of steam-sealed glands and the casing was connected to a condenser in which a vacuum of 29in. was maintained, and from which the water from the jets and the condensed steam from the glands could be removed by an extraction pump. The water supply to the jets was taken from the town main, the pressure being regulated so that the actual drop over the nozzles was 4 lb. per square inch. Under these conditions a total quantity of 400 lb. of water per hour was discharged through the eight jets.

The arrangement and disposition of the jets on a radial line was adopted with the intention of concentrating the impact at four local spots, so as to accelerate the action as much as possible and also to enable comparative results to be obtained at points corresponding to four different blade velocities at the same time. The results obtained, however, led to the conclusion that this arrangement did not represent the conditions in a commercial turbine to the degree of accuracy which it was desired to achieve. It was therefore decided to discard the original low-pressure jets and to install in their places two "White" oil-fuel burner jets. This type of jet discharges the water in the form of a spinning cone of finely divided particles. A section through the jet is shown in Fig. 14, and a reproduction from a photograph of the spray when discharging to atmosphere is given in Fig. 15. This spray seems to give as fair a representation of turbine conditions as is obtainable, and at the same time the conditions as to size and density of the drops are so uniform that direct comparison of the results of a series of tests can readily be made. With a pressure of 40 lb. per square inch on the jets, the water has a velocity of 50ft. per second when it reaches the blade ring and the quantity discharged is approximately 500 lb. per hour. This quantity was found to be sufficient to produce extremely rapid erosion and a fifty-hour test period was, in general quite long enough to enable the required comparisons to be made.

Another defect which quickly became apparent in the original design was that with the pitching chosen for the blades the depth of penetration was too restricted, as the angle of impact was only 3 deg. It was consequently found necessary to reduce the number of blades in the wheel. Not only is comparison difficult if the specimens are only affected on a very narrow strip, but also the results are likely to be misleading, owing to the covering effect resulting from slight imperfections in alignment. Even if the blades are set perfectly true in the first instance, the alignment will be upset as the test progresses by the fact that the erosion does not proceed at the same rate on all the blades. The pitching finally adopted gave a clear space of approximately 3in. between the blades.

The original apparatus was in use for a period of about two years, during which time a large number of tests were carried out, which enabled comparisons of a number of materials and a variety of blade forms to be made. The information obtained from the research was so useful that it was decided to extend it, and a new apparatus was constructed with which the conditions in turbines with higher blade speeds could be reproduced. The maximum peripheral speed was 870ft. per second in the original tester, and the majority of the tests were actually carried out at a speed of approximately 800ft. per second. The new apparatus was designed so that speeds up to 1100ft. per second could be obtained if desired.

In this machine a disc diameter of 26in. was adopted, and the spindle was mounted in a suitable cast iron casing and was driven by an electric motor through step-up helical gearing, the arrangement being such that disc speeds up to 8500 r.p.m. could be attained. The same form of oil burner was used for the water sprays and two of these were mounted at the mean diameter of the blades in the positions shown in the sectional drawing of the apparatus—Fig. 16. The blade height in this case was reduced to 2in., as it was found that this length was just covered by the spray cone, and gave a convenient area of erosion for the test samples with the nozzles set 1¾in. away from the blades. Reducing the blade height by omitting the inactive portion also had the advantage of keeping the centrifugal stresses on the blades comparatively low, and so a simple type of blade fixing could be used which materially facilitated the reblading of the disc each time a new set of specimens was to be tested.

With the shorter blades there was less likelihood of a test being spoiled by the fracture of a blade, an accident which did occasionally occur. The loss of a blade did not seriously affect the running of the new rotor, whereas the old one was thrown so much out of balance that it had to be shut down.

Photographs of the apparatus in its final form are reproduced in Figs. 17 and 18.

With the blade spacing adopted the disc carried thirty blades, and in the majority of tests about four specimens of each type were used, so that every test gave a direct comparison of some seven or eight different forms. After the disc was bladed and the samples numbered to correspond with the record charts, a test was run for 50-hour periods. Inspections during the course of the first 50 hours were made as necessary in each individual test, and those tests which were of sufficient interest were continued for further 50-hour periods. The specimens were judged by their condition at the end of this period. It was not found possible to obtain any useful data from direct measurements, such as loss of weight by erosion, but no difficulty was experienced in assigning figures of merit to the specimens by visual inspection or, what is really of more practical utility, in picking out those specimens which showed a definite superiority in respect of their resistance.

In the course of the investigations, the test wheel has been rebladed sixteen times, so that in all some 500 blades of nearly 100 different kinds have been subjected to test. The test samples covered a wide range of materials, and, in addition, the effects of heat treatment or condition, and also of the shape of the blade inlet were explored. The blades themselves were standard Parsons ¾in. blades, but in the great majority of the tests protective shields were fitted,

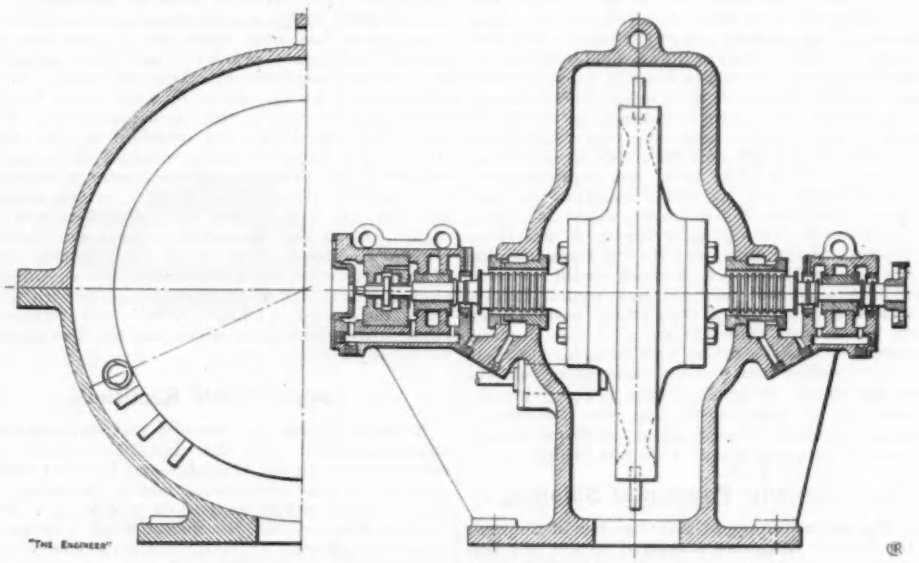


FIG. 16—FINAL FORM OF BLADE TESTING APPARATUS

and in these cases it was the shield and not the blade which was made of the material under test.

The range of materials tested included :—

Various non-ferrous alloys.
Carbon steels.
Manganese steels.
Stainless steels.
Austenitic steels and other nickel-chromium alloys.
High-speed tool steels.
Steels with special treatment to produce a hard surface layer.

At the outset of the investigation, it was realised that in general the harder the material the higher would be its resistance to disintegration by a purely mechanical action ; but it was not known definitely whether other factors might enter into the question

* No. II. appeared February 12th.

which would make some materials more suitable than others by virtue of properties not directly related to hardness.

In the earliest experiments therefore a great variety of materials in ordinary commercial use were tried with a view to elucidating this point. These first tests served to eliminate all the materials previously used for blades, and they showed that no special virtues were possessed by any of the non-ferrous alloys that were tried. The brass samples merely demonstrated the extreme rapidity with which a blade could be made to disappear by the impact of water drops at high velocity. Monel metal, which was the best of the group, was no better than ordinary mild steel. These experiments likewise showed that no special virtue was to be found in low carbon stainless steel; its behaviour was precisely the same as that of mild steel of equivalent hardness. Very promising results were, however, obtained with steels with a high nickel-chromium content, and their superiority seemed to indicate that the most resistive materials available for practical commercial application might be found amongst the austenitic steel group. Extensive use of this group was therefore made in subsequent tests. As the research progressed, however, it became clear that these steels did not possess resistance properties to any greater degree than other materials of equivalent hardness.

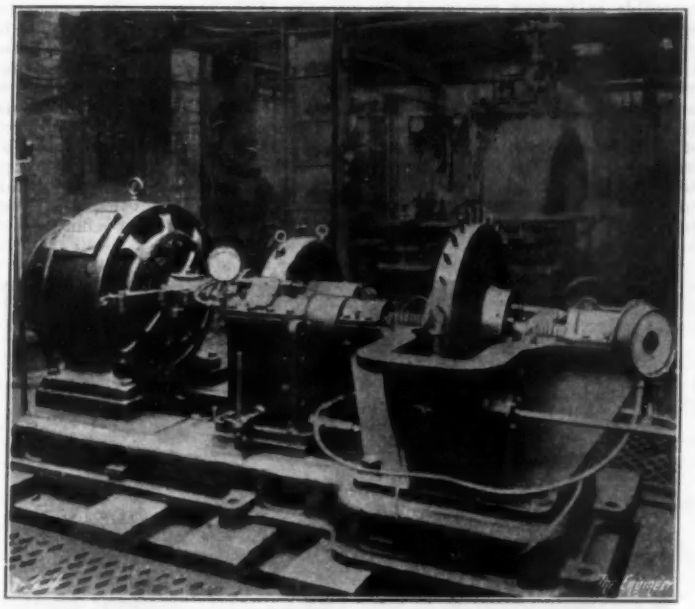
It must not be inferred from what has been said above that the austenitic steels have no merits for this particular application. They do possess a very fair degree of hardness after treatment at the temperature required for brazing. Furthermore, their effective hardness is considerably above the value given by an ordinary hardness test, owing to the fact that considerable work hardening is produced by the impact. Over the range of speed at which the original tester could be operated, say, up to 900ft. per second, excellent results were obtained with certain steels of this group. As a result of this experimental evidence these materials were adopted for commercial work, and a very large number of turbines are actually in service with shields of austenitic steel. These have been so effective in meeting the difficulty, that up to date there is not a single case in which the shields have had to be renewed, though some of them have been five years in operation at speeds which would have necessitated replacement of unshielded blades at relatively frequent intervals. A hardness figure of a much higher order is, however, obtainable with materials of the high-speed tool steel group. In the speed range of the later tests—that is, 1000ft. per second and above—the hard tool steels display a very marked superiority.

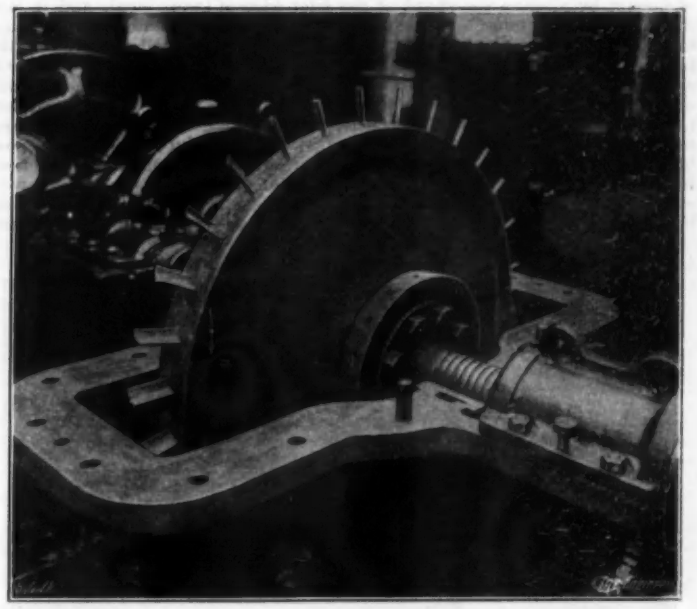
TABLE I.

No.	Material.	Composition.	Brinell No.	Estimated ultimate strength.
1	Austenitic steel	16 Cr, 10 Ni, 0·1 C	163	37
2	Ditto	18 Cr, 8 Ni, 0·1 C ..	182	42
3	Ditto	12 Cr. 36 Ni, 0·3 C	191	44
4	Ditto	Ditto	205	47
5	Ditto	18 Cr, 8 Ni, 0·1 C ..	210	48
6	Manganese steel	13% manganese ..	215	50
7	Austenitic steel	23 Cr, 11 Ni, 3 W, 0·45 C	232	54
8	Ditto	Ditto	238	55
9	Nickel chrome steel	4 Ni, 1·0 Cr, 0·3 C..	482	100
10	High-speed tool steel	18% tungsten	500	105
11	Ditto	Ditto	523	110
12	Ditto	Ditto	630	130

Fig. 19 shows a representative series of blades which have been picked from the test samples to illustrate the relation between hardness and rate of erosion. Details of the materials with their composition and respective Brinell numbers are given in Table I. In explanation of this table it should be stated that the examples given are chosen from a very large number of test samples, simply to give a wide range of hardness. It is not in any way implied that the samples chosen represented the best condition for that particular material.

There is a very noticeable change in the extent of the erosion in passing from No. 8 to No. 9. It will be seen from the table that there is a gap in the Brinell hardness number at the same point, as no samples were available in this range which were accurately comparable as regards the duration of test. With regard to the Brinell numbers, it should be pointed out that the figures were taken with a Firth hardometer, using a 2 mm. diameter steel ball and a load of 120 kilos. The steel ball is not entirely satisfactory for the very hard materials, as the accuracy of the figures obtained may be affected by possible flattening of the ball. The hard materials did, in fact, give considerably higher figures when tested with a diamond pyramid, but the steel ball figures have been used throughout, as this has been found the most satisfactory way of ensuring that all the figures are on a comparable basis.





FIGS. 17 AND 18—FINAL FORM OF BLADE TESTING APPARATUS

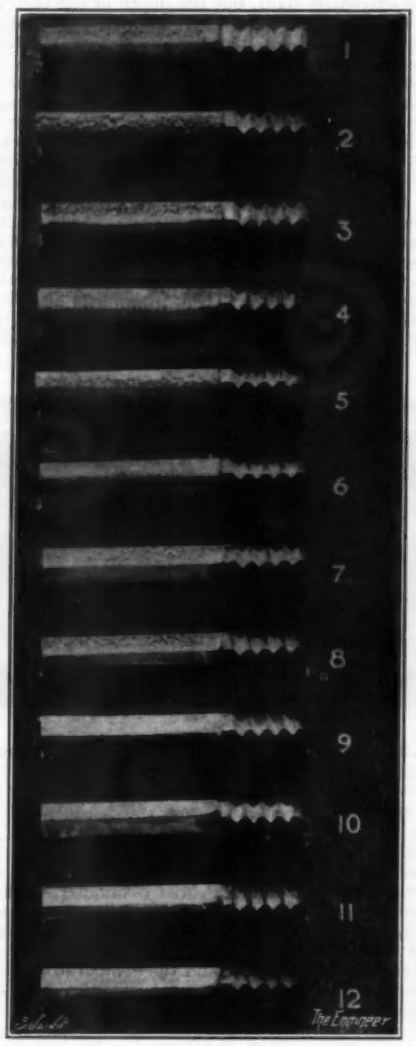


FIG. 19—SAMPLES OF TESTED BLADES

As the tungsten steels gave the best results, and seemed to be the hardest materials that could be conveniently employed in commercial practice, the tests on this group were extended to ascertain the influence of the condition of the material. As was anticipated, the relation between resistance and hardness was brought out very definitely by these tests. Fig. 20 shows a group of four pairs of samples, heat treated in different ways to produce different degrees of hardness. In each pair one blade is fitted with a shield of the usual type, and the other has a shield let in so as to finish to the profile of the normal blade. In deciding the treatment to be adopted, regard had to be paid to the methods used for fixing the shields in actual turbines, so all the treatments included a brazing operation which involved heating the shield to about 1000 deg. Cent. Taking the shield in the condition as rolled, brazing it on and leaving it to cool in still air was found to give a Brinell number of rather over 500. By accelerating the cooling after brazing by means of an air blast, the Brinell can be raised slightly. It can be raised still further if before brazing the shield is quenched from 1200 deg. Cent. On the other hand, heating above 750 deg. Cent. after brazing has a softening effect. By varying the treatment in this way a range of Brinell values was obtained. The Brinell numbers of the samples illustrated are given in Table II.:—

TABLE II.

Blade.	Brinell No.	Blade.	Brinell No.
No. 1	620	No. 5	585
No. 2	560	No. 6	525
No. 3	410	No. 7	350
No. 4	303	No. 8	320

These particular examples were made from 18 per cent. tungsten steel and when photographed had been under test for 135 hours at a speed of 1050ft. per second.

Example No. 1, with its Brinell of rather over 600 represents the hardest shield that can be satisfactorily employed commercially with the present methods of attachment. This specimen, it will be observed, is practically unaffected by the test of 135 hours' duration. Its surface, initially polished, has become matt over the area washed by the water, but no pitting such as is observable in varying degrees on the softer specimens has developed. Example No. 5 is nearly as good as No. 1, except for a line of pitting along the ridge of the shield.

Tungsten steel quenched and untempered may have a Brinell hardness considerably over 700, and a similar figure can be obtained with quenched cast steel. The materials in this state are, however, so brittle that they are apt to develop cracks or to shatter without warning, and even if convenient means of attaching them without heat were available there would still remain the risk of fracture in service. The tungsten steel has the merit that when it has been subjected to the brazing heat it retains an appreciably greater degree of hardness than would a carbon tool

steel treated in the same way. So far as the grade of tungsten steel is concerned, the experiments led to the conclusion that steels of higher tungsten content did not possess any advantage over the 18 per cent. grade.

Whilst the development of a hard shield was proceeding in this way, attention was also directed to the possibility of influencing the effective velocity of impact by altering the shape of the inlet edge of the blade. A number of comparative tests were made with the two forms of shield, which have already been described and referred to as the bull-nose and the bevel type. If the surface of the blade is oblique to its direction of motion, then the component normal to the surface of the relative velocity of impact with the water drop is reduced at a given blade speed, and the probable impact pressure should be correspondingly diminished. The experimental evidence indicates that when operating in the neighbourhood of the critical point, the bevel does possess

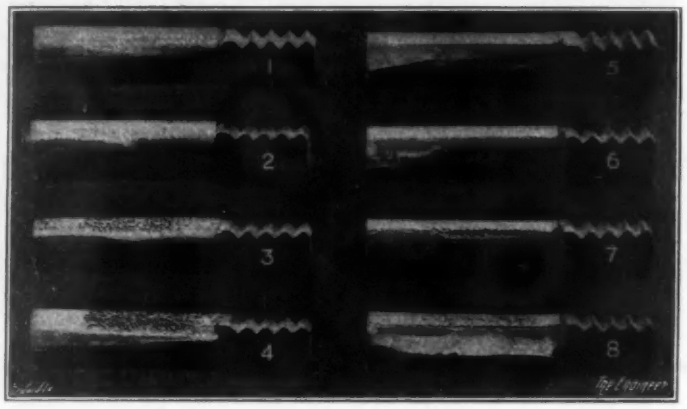


FIG. 20—BLADES WITH SHIELDS OF 18 PER CENT. TUNGSTEN STEEL

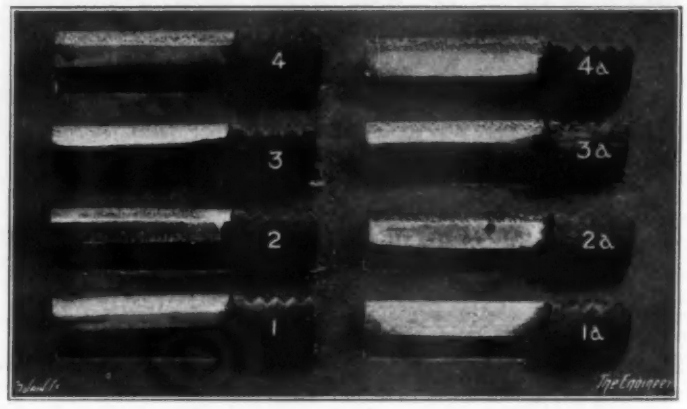


FIG. 21—BLADES WITH BEVELLED AND BULL-NOSED SHIELDS

an advantage. If, however, the material is so soft that the critical velocity is greatly exceeded, the surface quickly becomes pitted and the advantage of the bevel feature is then largely destroyed. A bevel of about 45 deg. has been found most suitable. A smaller angle is not so effective because the obliquity is less, whilst, in the other direction, a limit is imposed by the necessity of making the bevel extend behind the limit line of the impact—see Fig. 4. These experiments are illustrated in Fig. 21, in which four pairs of blades are compared. They were photographed after 50 hours under test at 1050ft. per second. All the blades in the left-hand row have a bevel shield, and in each case the corresponding blade in the right-hand row has a bull-nose shield of the same material and Brinell value. The first pair—Nos. 1 and 1*a*—are hard tungsten steel, and in this case the bevel is scarcely affected, but erosion has started on the bull-nose sample. The other three pairs are different steels, but all are in the soft condition, well below the critical, and although the advantage lies with the bevel, the erosion has in all cases proceeded so far as to make the comparison somewhat indefinite.

The effect of the bevel is also well illustrated by the four right-hand specimens in Fig. 20, as the bevel in this case did not completely cover the exposed area. In all four blades the erosion is much more severe on the part beyond the bevel. In the case of No. 5 sample, it is only on this portion that erosion is visible at all.

The researches have included some investigation of the possibility of protecting the blades by a form of surface treatment, such as chromium-plating or nitriding. These experiments have shown quite definitely that a soft material cannot be rendered more resistive by the addition of a hard, but very thin surface layer. It must be remembered that the pressure resulting from impact is developed instantaneously and that the stresses thereby produced are propagated through the material by a compression wave. Under these circumstances, it is reasonable to suppose that the stress developed immediately below the surface layer is practically as high as that in the layer itself. The soft material will be stressed beyond its limit with consequent eventual failure, and the extremely thin and brittle surface layer thus left unsupported will quickly crack and break up.

Nos. 1 and 2 in Fig. 22 are examples from a number of chromium-plated blades that were tried. No. 1 had a bright plating with a thickness of 0·0004in. No. 2 was plated 0·002in. thick and had a matt surface. In both cases the chromium was deposited direct on to mild steel blades. Judged by its resistance to a smooth file the plating itself was quite hard, but a Brinell test only gave figures corresponding to the mild steel of the blade, and the chromium was found to have developed cracks at the edges of the impression made by the ball. This would appear to be an effect precisely similar to that obtained in the tester, though rather differently produced. As will be gathered from the figure, the chromium was very rapidly disintegrated, and erosion of the mild steel proceeded as violently as if it had never been plated.

In these tests the soft blade material was chosen deliberately. Had the blades been harder they would have shown less erosion, but the rate would still have depended on the blade and not on the plating. As chromium is a very hard metal, its resistance will be exceedingly high, but advantage could only be taken of this if plating of much greater thickness were used, and it is hardly possible at present to estimate what thickness would be necessary. Its Brinell number is of the order of 550, which is rather below that obtainable with the tungsten steel shields; plating of these would therefore serve no useful purpose. The ordinary commercial applications of chromium-plating require only extremely thin films, and the electro-deposition of very thick coats of chromium has only recently received attention.

Nos. 3 and 4 are examples of nitrided blades. The Brinell figures obtained from the nitrided surface varied from 320 to 450, as compared to 140 on the untreated nitralloy steel from which the blades were made. The surface when tried with a file appeared to be extremely hard, but the depth of the case was not known. The initial resistance of these blades to erosion was high, but by the end of 150 hours under test at 1050ft. per second the surface was heavily pitted all over, as shown in the figure, the action being doubtless similar to that experienced with the chromium-plated blades.

Nos. 5 and 6 are blades fitted with shields which were treated by the process known as "cloudburst" hardening. These shields were made of tungsten tool steel. Hardness figures taken with a pendulum tester indicated that the surface hardness was increased some 25 per cent. by the "cloudburst." Brinell tests on this treated surface showed considerable variation, but the specimens figured gave values somewhat below 600. These specimens had been under test for 150 hours at a speed of 1050ft. per second. At the end of this period incipient erosion

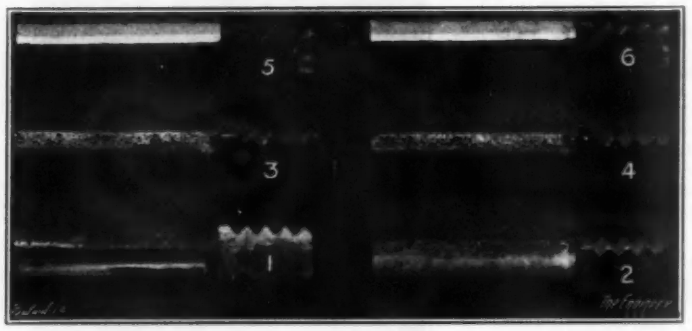


FIG. 22—CHROMIUM-PLATED, NITRIDED, AND "CLOUDBURST" HARDENED BLADES

was discernible, indicating that in this case, too, the criterion of resistance was the hardness of the metal underneath rather than the treated skin.

The general conclusions to be drawn from this experimental investigation have already been discussed, and need only be briefly summarised here. First, the property which determines the resistance of a material to erosion by water impact is hardness. This property is most conveniently measured by a Brinell or equivalent test and the comparative resistance of different materials may be predicted directly from their Brinell numbers.

It appears logical to suppose that ductility would influence the rate of disintegration by erosion as between two materials of equal hardness. This, however, can only be inferred and has no direct practical application, because amongst materials of the class which, by virtue of their extreme hardness, are most effectively employed to resist erosion at high impact speeds, it is not possible to obtain any appreciable ductility.

In commercial practice the greatest degree of hardness can be obtained with the high-speed tool steels appropriately treated and these have been shown to possess the highest resistance and have been found to be the most suitable for blade protection.

Water impact will cause erosion even though the yield point of the material is far above the calculated value of the resulting fluid pressure. Local stresses must therefore be set up in the metal, which greatly exceed the intensity of the pressure. It is suggested that these high stresses may be accounted for by minute irregularities in the metal surface. As a consequence of this, though theoretical considerations enable an expression to be found connecting the fluid pressure with the velocity of impact, no similar relation exists between the velocity and the stress produced in the metal. It is therefore not possible to deduce any useful relation between the yield point of a material and its resistance or to obtain experimental confirmation of the calculated value of the pressure. For the same reason it is not possible to find for any material a limiting or critical value for the impact velocity, below which erosion cannot occur.

ESTIMATION OF THE PRESSURES PRODUCED ON THE BLADE SURFACE BY THE IMPACT OF WATER DROPS.

This question is most easily approached by considering the simplest case of collision, namely, that in which a uniform cylindrical rod impinges on a fixed inelastic surface. If an elastic rod, moving with a uniform velocity V parallel to its length, strikes a normal fixed surface, so that the motion of the leading end is suddenly arrested, then the pressure at this end rises instantaneously to a value given by the equation:

$$P = V\sqrt{\frac{\rho E}{g}} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where P is the intensity of pressure, ρ the density, and E Young's modulus for the material of the rod. The elementary sections are successively brought to rest by a compression wave which travels along the rod with the velocity of sound, and during the interval required for this wave to reach the far end, the same intensity of pressure is maintained on the plate. This interval t will be L/v, where L is the length of the rod and v is the velocity of sound in the material of which the rod is composed. (It is assumed that the pressure generated is uniform across the whole face of the rod, and that the wave front remains plane throughout. For the case considered, no appreciable error is introduced by this assumption.)

$$\text{Since} \quad v = \sqrt{\frac{E\,g}{\rho}} \quad \therefore \quad t = L\sqrt{\frac{\rho}{E\,g}} \quad . \quad . \quad (2)$$

On reaching the far end of the rod the wave is reflected as a tension wave, which travels back along the rod, reconverting the potential energy into velocity energy. This requires a further interval t, and during this interval also the pressure is maintained on the plate. At the end of the total interval $2t$, the rod rebounds from the plate and the pressure is instantaneously released.

When a spherical drop of fluid strikes a plate, the distribution of pressure on the surface of contact will not be uniform, but the maximum intensity can be inferred directly from the preceding case. The initial contact will occur over a small area of the drop, and this surface can be regarded as the end of a cylindrical core of fluid which in the initial stages of the impact will behave as a solid rod. It must be assumed that being surrounded by the rest of the fluid in the drop,

it will be prevented from spreading laterally. Over this small area, therefore, the intensity of pressure can be obtained directly from equation (1) by substituting the modulus of compressibility of the fluid for Young's modulus. Calling the modulus of compressibility C:

$$P = V\sqrt{\frac{\rho \cdot C}{g}} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Owing to the deformation of the drop and lateral spread of the fluid, the motion will very quickly cease to correspond to that of a solid rod. If it is assumed, however, that for reasonably small drops the pressure will be maintained during the first interval t of equation (2), this now becomes:

$$t = D\sqrt{\frac{\rho}{C \cdot g}} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where D is the diameter of the drop.

Equation (3) gives the pressure corresponding to any given values of V, ρ, and C, and shows that it varies as the first power of the velocity, and is independent of the size of the drop. The form of equation (4) shows that the duration does depend on the size of the drop, but is independent of the velocity.

The particular case of fluid impact with which these articles are directly concerned is the impact of water on the surface of a metal blade, which is itself moving at high velocity. The formula derived above is equally applicable when the surface itself is in motion, provided V is taken as the relative velocity. For present purposes the water drop may be regarded as being sensibly at rest, so that V becomes the velocity of the blade. The possible intensity of pressure that can be produced by impact may therefore be expressed directly in terms of the blade speed.

Before arithmetical values can be obtained, it is necessary to know the values of ρ and C, and here a difficulty arises because for water neither of these is independent of the pressure. The modulus of volumetric compressibility varies considerably. At atmospheric pressure it is $4 \cdot 32 \times 10^7$ lb. per square foot. Its value is just about doubled at a pressure of 15 tons per square inch. The effective value that should be used for equation (3) is very uncertain, and, further, depends on the validity of the assumption that lateral spread is entirely prevented. This condition is most likely to be fulfilled when the impact takes place at the apex of a cavity in the blade surface.

For the purpose of obtaining an idea of the order of the resultant pressure for a velocity of 1000ft. per second, the following values will be taken. They have been calculated from the known data, as appropriate for the pressure range involved.

$$C = 8 \cdot 0 \times 10^7 \text{ lb. per square foot}$$

$$\rho = 67 \cdot 5 \text{ lb. per cubic foot.}$$

A small correction must also be made for the fact that the impact occurs on the surface of an elastic metal and not on a rigid body. This correction is easily evaluated and reduces the pressure by 5 per cent.

Equation (3) then gives:

$$P = \frac{0 \cdot 95 \times 1000}{144 \times 2240} \times \sqrt{\frac{67 \cdot 5 \times 8 \cdot 0 \times 10^7}{32 \cdot 2}}$$

$$= 38 \text{ tons per square inch.}$$

It should be pointed out that if C changes with the pressure, the statement that the pressure is proportional to the velocity is not universally true, because a higher velocity implies an increase in the effective value of C also. For reasonable ranges of velocity, however, such as would ordinarily be compared in turbine work, the pressure does vary closely as the first power of the velocity.

The mathematical theory of cavitation was developed by Cook*, who derived the equation:

$$P = \sqrt{\frac{2}{3} p \cdot C \cdot \frac{R^3 - r^3}{r^3}}$$

where P is the intensity of pressure that is produced by the collapse of a spherical cavity of radius R on a nucleus of radius r and p is the pressure of the fluid surrounding the cavity. From this it appears that the pressure depends on the ratio of the initial volume of the cavity to the volume of the nucleus, and if it be assumed that the collapse follows the condensation of steam to water, the value of the pressure can be calculated.

Suppose, for example, that the absolute pressure were 1in. of mercury, then the pressure p would also be 1in., and the ratio of the volume of steam to water would be approximately 40,000. Taking the same value for C as before, this would give a value for the collapse pressure of about 38 tons per square inch, or nearly equal to the impact pressure resulting from a velocity of 1000ft. per second. As a matter of interest, since the ratio of the volume of saturated steam to water varies nearly inversely with the pressure, the collapse pressure as arrived at in this way does not vary appreciably with the vacuum in the turbine. It may be well to point out, to avoid possible misunderstanding, that this statement refers to the collapse pressure only. It does not imply that the rate of erosion, produced by this action, would be independent of the vacuum.

Though it does not appear to be possible to develop a more rigorous theory from which the cavitation pressures in this particular case can be derived, the reasoning followed above may be accepted as giving a fair indication of the limiting values, and it leads to the conclusion that the maximum pressures that could be produced by cavitation effects could hardly be greater than those resulting from direct impact at the speeds usually met with in modern turbines.

It would seem, however, that to be favourable for the occurrence of cavitation, the conditions would have to be rather special. The initial compression of the entrapped vapour would be adiabatic, so that it would be highly superheated, and if condensation were to take place suddenly a remarkably rapid transfer of heat to the metal of the blade would be required. It may be objected that at the instant of collapse the vapour would be highly compressed. This could, however, be balanced by a corresponding rise of pressure in the surrounding liquid. Perhaps the most serious difficulty arises from the fact that in practice the drops will be extremely small, whereas the theory presupposes the extent of the fluid to be great in comparison with the dimensions of the cavity. An action of this nature is difficult to visualise with drops only a few thousandths of an inch in diameter.

In concluding this series the author acknowledges his indebtedness to C. A. Parsons and Co., Ltd., for permission to make use of the investigations which they have carried out, and also to his associates at Heaton Works and at Turbinia Works for invaluable assistance in the preparation of these articles.

* "Trans.," Inst. Naval Architects, Vol. LXI., 1919.

The Jetty Works of the Ford Motor Company at Dagenham.*

By HENRY JAMES DEANE, M. Inst. C.E.

THE reinforced concrete jetty described in this paper is laid out for dealing with imports of ore, limestone, &c., in connection with the manufacture of the Ford Motor Company's cars at Dagenham and for the export of the finished product. It is situated on the river Thames in Half Way Reach, about 13 miles downstream from London Bridge, and is connected with the land by a curved approach at each end. The western portion, which is single-decked, is provided with crane tracks of 17ft. gauge back and front, for 10-ton cranes. The eastern portion has two decks, the upper deck being supported on steel work, the stanchions of which rest on the reinforced concrete work. The upper deck carries two travelling ore unloaders, each capable of discharging vessels at the rate of 300 tons per hour. The ore, &c., after being weighed at the unloader, is transported at the high level to the storage ground on shore by electrically propelled wagons of 40 tons capacity. There are two railway lines on the lower deck, giving access to the shore at each end and provided with two scissor cross-overs.

The jetty is 1515ft. in length and 51ft. wide, and is supported on hollow reinforced concrete piers 6ft. and 7ft. in diameter, according to the load they have to carry. They are spaced 24ft. apart between centres longitudinally and 40ft. transversely. The foundations of the piers consist of cylinders 12ft. and 14ft. 6in. in diameter, filled with concrete. Transversely there are heavy portal beams between the piers, into which are formed the deck beams. The reinforced concrete deck is 1ft. 7in. below the finished surface, the intervening space being occupied by rail supports, pipe trenches, electric ducts, &c. All waste spaces are filled with inundated Thames ballast, and a concrete surface is provided over the whole area. There are two fixed steel bridges, one to each approach, which allow of access to the inshore side of the jetty.

The depths of water provided for are 13ft. 6in. at the western berth and 20ft. at the eastern end, below L.W.O.S.T. The jetty is divided into four sections by transverse expansion joints placed in the centre of the respective spans, the deck beams being designed as cantilevers. The impact stresses for which the calculations were taken out were a 12,000-ton ship approaching broadside on at 6in. per second, the whole load resulting therefrom being assumed to be spread over three bays. To absorb this energy spring fenders are provided, two to each bay, consisting of double 14in. piles driven about 18ft. into the bed of the river and resting against helical steel springs. Provision is made to allow some longitudinal movement of the pile heads without introducing side stresses in the springs. Floating booms help to distribute the load to the piles and to take up any ranging of the ships.

The sinking of the cylinders for the pier foundations was accomplished by grabbing and by loading with kentledge. Considerable difficulty was experienced in excavating a hard layer of cemented sand and ballast which was found at depths varying between 37ft. and 47ft. below O.D., but by the aid of hydraulic jets and blasting the material was broken down to a condition suitable for excavation by grabbing. In sinking the cylinders, of which there were 151 in all, difficulties were met with in several cases due to canting. One or two accidents occurred from this cause. The sealing of the bases was effected by lowering concrete in suitable skips to the bottom and, after the cylinders were proved to be reasonably tight, the water was pumped out and the construction of the piers was commenced by forming the concrete hearting from which the reinforced concrete work was built up. After the piers were finished up to a certain level the water was let in and the temporary rings were removed. A case is described where the water pressure below the seal was sufficient to lift the cylinder and its kentledge. Two cases where compressed air had to be used are recorded, both being for the purpose of making good seals which had given a considerable amount of trouble. A number of observations are given, in the form of diagrams, of the variation of water levels inside the cylinders after water-bearing ballast had been struck. These prove the connection of the stratum with the tidal waters. Other diagrams give the recorded effects of the rise and fall of the tides on the river bed; from these a decision was arrived at that it would be impracticable to use the foreshore as a floor from which to support the formwork for the concrete in the approaches. The method and instrument used for testing and measuring the deflections and deformations of the reinforced concrete work are described, as well as the means adopted for eliminating the rather serious errors which were at first encountered.

* Abstract of a paper to be brought forward for discussion at the Institution of Civil Engineers.

Adhesion and Fatigue of Thin Coatings of White Metal on Mild Steel Surfaces.

THE cracking of white metalled bearings under service conditions and the possibility of improving the fatigue strength of the white metal has been investigated at the National Physical Laboratory to find the effect of composition and method of application on the adhesion and fatigue of such coatings. Rings of mild steel, 3in. in external diameter, 1·5in. long, and 0·15in. thick, were lined with white metal to a thickness of 0·02in. by various makers and were subjected to a predetermined cycle of bending stress at a frequency of 3000 per minute. No attempt was made to introduce a frictional resistance at the surface of the white metal, but to imitate the conditions of practice the tests were made at a temperature of approximately 120 deg. Cent., and the surface of the white metal was covered with oil. Tests were also made on steel rings lined with lead bronze and supplied by the Allison Company of U.S.A. Finally, one of the lead bronze lined rings and a ring lined with Richards' A.C.E. white metal were tested for coefficient of friction at various pressures and temperatures in the N.P.L. journal-bearing testing machine. At various stages of the test the liner was examined and the progress of the cracks noted. The initial adhesion of the white metal to the steel was also measured by a method specially devised for the purpose. Comparison of the behaviour of white metal liners (1) cast and (2) centrifuged, was also made, and the distribution of the constituents of the white metal resulting from the centrifuging was investigated.

The tests of the strength of the static adhesion of the white metal to the steel indicated that in the best practice the adhesion was fully equal to the ultimate shear stress of the white metal. Under long-continued alternation of stress within the fatigue limit of the steel to which the white metal was attached, the surface of the latter rapidly became covered with a network of cracks, and in all the methods and materials tested, with the exception of the lead bronze, its adhesion to the steel was ultimately destroyed. In the best practice it was found that the complete destruction of the adhesion was only effected when the stress was a large fraction of the limiting fatigue stress of the steel and the number of repetitions of the order of 15 millions. In the case of the steel rings lined with lead bronze supplied by the Allison Company, no apparent deterioration in adhesion and comparatively insignificant fatigue cracking of the liner was apparent after 15 million cycles of stress at a range of 18·9 tons per square inch. It was clear that in both respects the merits of this alloy were of an entirely different order from those of the other so-called white metals. A very complete series of comparative tests in the N.P.L. journal-friction testing machine at high loads—up to 2500 lb. per square inch—and with various lubricants indicated a performance of the lead bronze under forced lubrication and continuous rotation which was fully equal to that obtained from one of the best tin-base alloys.

The experiments on this subject were carried out by the late Sir Thomas Stanton and an account of them is given in a report—R. and M., No. 1424—which has recently been published for the Aeronautical Research Committee by his Majesty's Stationery Office, price 6d. We understand that following experimental work at the Royal Aircraft Factory, Farnborough, lead bronze bearings of the type described in the report are now being made in this country by Rolls Royce, Ltd., and by D. Napier and Son, Ltd., at whose disposal the results of the Farnborough investigation were placed.

MANCHESTER ASSOCIATION OF ENGINEERS.

AT a meeting of the Manchester Association of Engineers, held on February 12th, a paper entitled "Cost Control in the Engineering Industries" was read by Mr. Harold Wilmot, F.S.S. The author said that the implications of the word control were fourfold:—(1) A defined aim or ideal; (2) an immediate knowledge of actual performance; (3) an appreciation of the difference—if any—between the ideal and the actual; and (4) a capacity to make and an authority to enforce decisions for the purpose of the elimination of any difference between the ideal and the actual. The engineer and technician regarded his problem down the line of flow of materials and effort, while the accountant looked at the same problem down the line of flow of cash. These two view points were directly opposite in direction, and that fact alone had in the past contributed to a lack of sympathy between engineer and accountant that could produce nothing but ill in the practical affairs of company operation. That kind of thing could not be tolerated to-day, and it was being increasingly realised that the conditions of modern industry made it imperative that technicians should have accounting appreciation and accountants should have technical appreciation. Only thus could there be a common platform and general sympathy from which might spring that spontaneous co-operation and co-ordination which was all-important for success.

British Industries Fair, Birmingham

No. I.

WE give with the present issue a special eight-page illustrated Supplement devoted to the engineering exhibits to be shown at the Birmingham Section of the British Industries Fair, which opens to the public on Monday next. In our issue of next week a similar Supplement will be included, whilst we shall continue at the same time the short series of descriptive articles of which this is the first.

There are, of course, the other two sections of the Fair, at Olympia and at the White City, in London, but with them we do not propose to deal, as they are only indirectly connected with the engineering industries. While all three sections will be opened simultaneously on February 22nd, the closing dates will be March 3rd at Olympia, March 4th at Birmingham, and March 5th at the White City. The Birmingham Section will be open daily from 10 a.m. to 6 p.m.

There will be no formal opening ceremony in any section of the Fair. Business will begin as soon as the doors are opened. The opening will be celebrated as usual at the Government banquet at the Mansion House, London—by permission of the Lord Mayor—on the night of the opening day, February 22nd, when H.R.H. The Duke of York will be the principal speaker, with the President of the Board of Trade in the chair. The Lord Mayor of Birmingham will be present at Castle Bromwich on the opening day. Royal visits are expected as follows :—H.R.H. the Duchess of York at the White City on Monday, February 22nd ; H.M. the Queen at Olympia on the mornings of Tuesday, February 23rd, and Wednesday, February 24th ; H.R.H. the Prince of Wales at Castle Bromwich on the afternoon of Thursday, February 25th ; H.M. the Queen at the White City on Friday, February 26th.

Among the functions arranged in connection with the Birmingham Section that will be of interest to engineers there are :—On Wednesday, February 24th : The Electrical Contractors' Association, the Electrical Contractors' Association of Scotland, the Association of Consulting Engineers, the Association of Supervising Electrical Engineers, the Illuminating Engineering Society, the Institution of Mechanical Engineers, and the British Engineers' Association. On Friday, February 26th : The Institute of Quarrying and the Association of Mining Electrical Engineers. On Saturday, February 27th : The Electrical Power Engineers' Association, and the Institution of Electrical Engineers, Students' Section, South Midland Centre. On Monday, February 29th : The Institute of Metals. On Tuesday, March 1st : The British Cast Iron Research Association, the Institute of British Foundrymen, the National Association of Heating, Ventilating and Domestic Engineers, the Institution of Structural Engineers, and the Machine Tool Trade Association. On March 2nd : The Institution of Electrical Engineers and a large number of other electrical and gas societies ; also the Newcomen Society. On Thursday, March 3rd : The Institution of Municipal and County Engineers and the Birmingham and District Association of the Institution of Civil Engineers.

BABCOCK AND WILCOX, LTD.

The exhibits which will be shown by Babcock and Wilcox, Ltd., and its subsidiary companies will comprise a very comprehensive display of boiler-house equipment and auxiliary plant. The boiler exhibits have been chosen to illustrate the newest designs of each boiler type. Progress in water-tube boiler design is exemplified by a full-sized section of the "S X" marine boiler, one of which is being supplied to H.M.S. "Guardian," a combined net-layer and target-towing ship, built at Chatham Dockyard. That boiler is now undergoing successful official trials at Renfrew. It has a designed output of 91,000 lb. of steam, a heating surface of 5850 square feet, and a working pressure of 250 lb. per square inch. Drawings of it were reproduced in THE ENGINEER of September 25th last. A further full-sized section of a Bailey hopper-bottom furnace is also to be exhibited on the stand. It has been arranged to show the detailed construction of the Bailey water wall and its immediate application to furnace designs for power stations and industrial plants. Another boiler exhibit is an 11ft. wide, 14ft. long, style 28, chain grate stoker, which is to be shown in operation. Sections of the chain bed will be specially linked up in order to render visible the system of air admission, through the return rim of the chain, thereby giving a maximum cooling effect on the links. This exhibit will also show the latest type of arches setting of Bailey construction, which, we are informed, is now practically standard for power station design. Another stoker which will also be shown in operation is the three-retort Erith Roe stoker, manufactured by Eriths' Engineering Company, Ltd. The stoker will be complete with a double-roll clinker grinder. Access to the feed end of the plant is given by a gallery with Babcock patented interlock steel flooring. The stoker, which was fully described in our issue of December 7th, 1928, is so designed that widths up to 30ft. can be supplied. Other exhibits on the stand will include a 14ft. long, 8ft. diameter Economic dry-back boiler, and a half 9ft. diameter Lancashire boiler by Edwin Danks and Co. (Oldbury), Ltd., of Oldbury, near Birmingham, while the waste heat installations of Spencer-Bonecourt, Ltd., and the plants of the Stirling Boiler Company will be represented by models, photographs, and drawings.

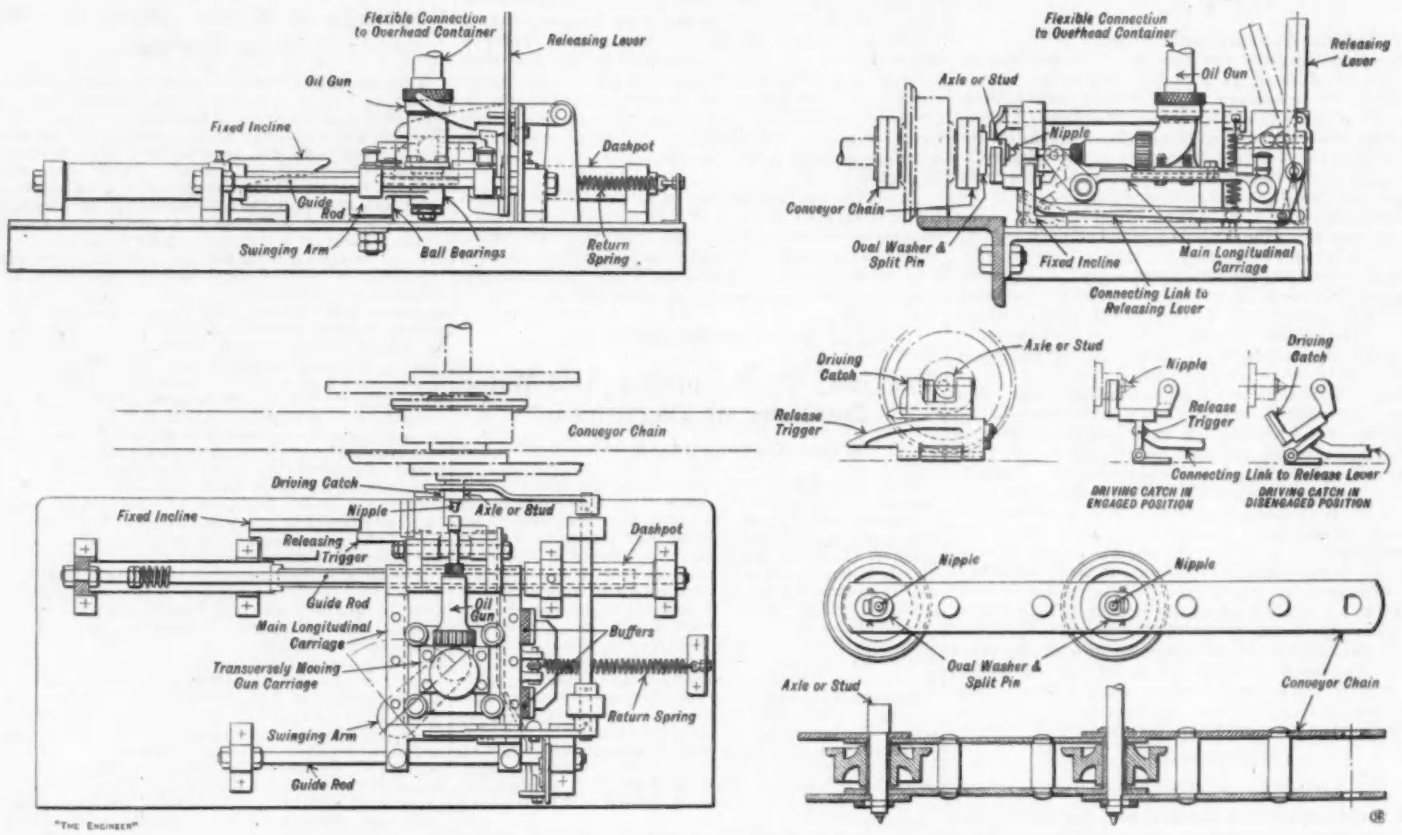


FIG. 1—AUTOMATIC LUBRICATOR FOR CONVEYOR CHAINS—BABCOCK

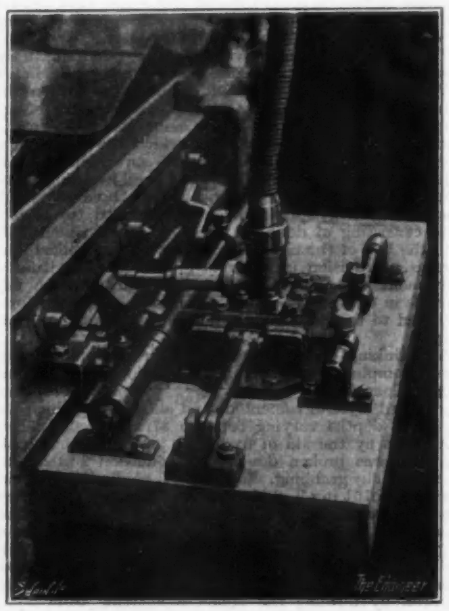


FIG. 2—OIL GUN—BABCOCK

Other exhibits of boiler plant will include a duplex oil pumping and heating unit and a Babcock oil burner. A full-sized plate type air heater, two sections high, and a forged steel return bend economiser will also be shown, together with examples of piping and valves, one of the latter being an 8in. parallel slide valve with Babcock-Tate electrical control gear.

An interesting item which we have chosen for illustration is the automatic lubricator for conveyor chains, shown in Figs. 1 and 2 herewith. This oil gun—a general view of which is reproduced in Fig. 2—has been designed to work continuously without any attention, except that of moving a lever to put the gun in or out of action, and the filling up of the oil reservoir from time to time. In order to operate the oil gun the axles or studs project beyond the chain, to which they are secured by a special shaped oval washer and split pin, engaging with a groove turned on the axle or stud end, thereby allowing a clear axial space for the oil gun nipple and the internal oil passages. This arrangement is clearly shown to the right of Fig. 1. As the drawings Fig. 1 indicate, the projecting axle or stud engages with a catch on the main carriage of the gun, which then moves in the same direction as the chain until the gun has travelled the requisite distance, when the catch runs under a fixed incline which pulls it out of engagement with the axle. The gun carriage is then returned to its original position for another operation by means of springs, the shock being absorbed by buffers and dashpots.

As will be seen from the drawing, there is mounted on the longitudinal travelling carriage another carriage carrying the gun itself, which is arranged so

as to move transversely to the longitudinal travelling carriage. The necessary transverse motion is imparted to this carriage by a swinging arm pivoted on the fixed entablature of the machine, which is connected to the transverse moving carriage so that the longitudinal movement of the first-named carriage imparts a radial movement to the swinging arm, causing the gun to move towards and away from the conveyor chain. At each movement the gun engages with a nipple on the end of a conveyor axle or stud, the travel of the gun being so timed as to allow a definite quantity of lubricant to be forced into the bearing.

A start and stop lever is provided, and there is a brush which automatically wipes the nipple free from dust prior to the application of the gun. In general practice two guns are employed, one on each side of a conveyor chain. It has been found that by using the two guns so placed for periods of less than half an hour, two or three times a week, the chain is thoroughly lubricated with a very moderate consumption of oil.

Another interesting item will be the patented totally enclosed steam trawl winch, illustrated in Fig. 3. This winch, which follows closely the firm's standard design, embodies a rotary distributing valve, driven by gearing from the engine crank shaft. As our drawing indicates, the whole of the reciprocating parts and the valve gear mechanism are enclosed, and the various controls are neatly grouped within easy reach of the operator. A feature of the design is the arrangement whereby the weight of each barrel is taken on its outer pedestal bearing and a corresponding bearing on the gear case, the driving shaft running freely, within the barrel centre, through to the warping ends. Thus when one barrel only is being used wear on the other is avoided. All the bearings are large and they are provided with continuous lubrication. The valve gear, we are informed, has shown itself to be very efficient over long periods of service, the cut-off and release remaining unaltered, owing to the fact that the only alteration in setting which can take place is that due to the infinitesimal wear on the bevel wheels driving the rotary steam distributing valve.

As shown in Fig. 3, the rope barrels can be furnished with hand-operated reeving gear, consisting of two large diameter, long, cast iron rollers operated through a rack and pinion, provision being made to move the rollers to one side when it is desired to pay off the rope freely. The winch which will be exhibited has 7in. diameter and 12in. stroke cylinders, designed for 200 lb. steam pressure, and the engine runs at 200 to 230 r.p.m. It is double geared with clutches, and the barrels are designed to take 360 fathoms of 2¼in. circumference rope, or more, as may be required. The double warp ends are of standard pattern.

Two other exhibits will be Babcock oil engines, namely, a 15 B.H.P. medium compression, horizontal oil engine—not illustrated—and a new design of cold-starting oil engine with airless injection—illustrated in Figs. 4 and 5. This unit is an 85 B.H.P. engine, with a 14¾in. diameter piston with a stroke of 20in., running at 250 r.p.m. A series of such engines is projected, embracing single-cylinder units from 35 up to 85 B.H.P., and 100 and 170 B.H.P. twin-cylinder units, running at speeds from 350 to 250 r.p.m., according to size. Port scavenging is adopted with crank case compression, the crank case cover being of a patented design, giving easy access to all moving parts. The air filter is placed within the air inlet cover, and can be removed and cleaned while the engine is running. The makers have adopted a roller bearing for the gudgeon pin, and oil is supplied to this bearing from centrifugal oil catcher rings, which are furnished with steel wipers which collect the used oil from the crank pin and pass it forward through the centre of the connecting-rod to the small end bearing. It may be observed that a small pocket or weir is arranged just below the liner to catch any oil from the cylinder, which is led off to a separate drain outside the engine bed. The bottom of the crank case is drained by the pipe shown. A mechanical lubricator supplies oil to the principal parts of the engine. Other points we may call attention to include the very simple and symmetrical form of water-cooled cylinder head adopted, the self-contained fuel pump and governor unit, and the flexible connection for the exhaust pipe. In order to enable a wide range of fuel oils to be used an Auto-Klean fuel filter is provided, and is attached to a facing on the exhaust pipe, so that it also serves as a heater for the fuel supply. The rated full load fuel consumption of the engine we have described is 0·4 lb., or 182 grammes, of oil per B.H.P. hour, while the lubricating oil consumption works out at 0·005 lb. per B.H.P. hour.

(To be continued.)

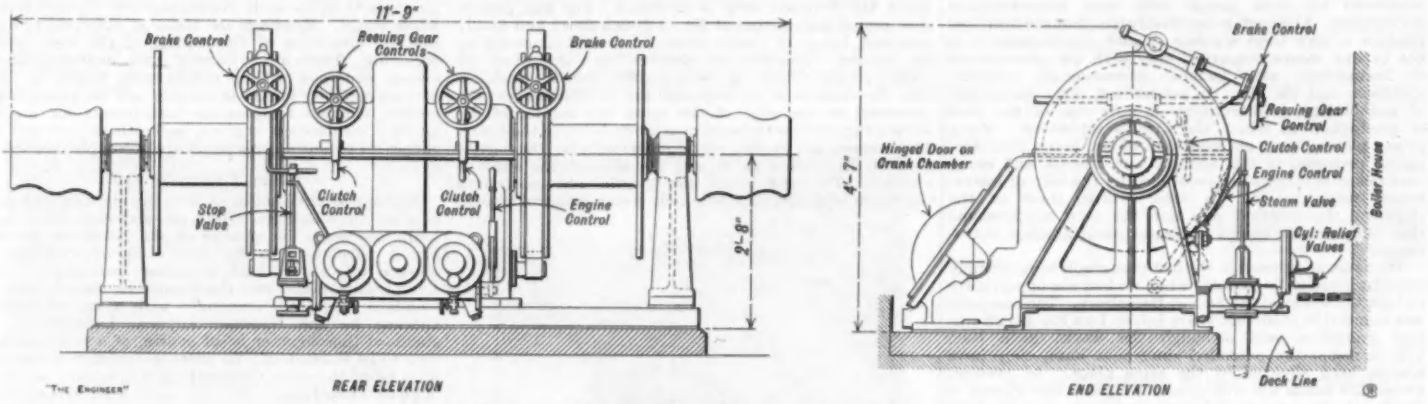


FIG. 3—TOTALLY-ENCLOSED STEAM TRAWL WINCH—BABCOCK

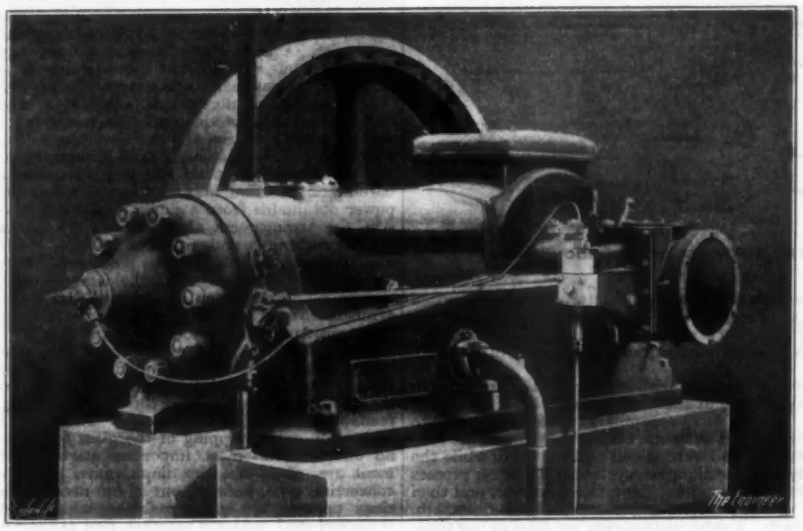


FIG. 4—85 B.H.P. COLD-STARTING OIL ENGINE—BABCOCK

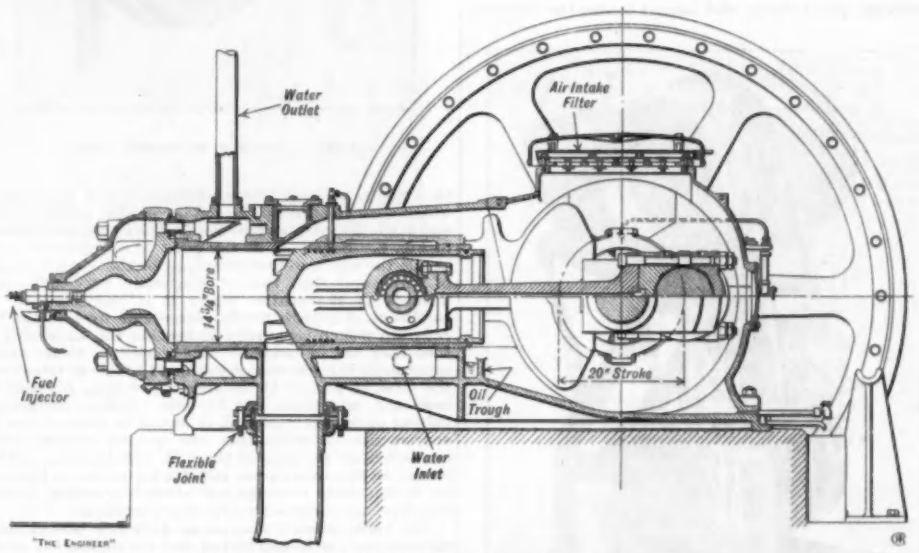


FIG. 5—85 B.H.P. COLD-STARTING OIL ENGINE—BABCOCK

GREATER ROBINSON DEEP MINE.

THE recent merging of the Village Deep and Robinson Deep gold mines, on the Rand, in one, has proved to be a judicious step, since, by centralisation of work great economy has been effected and the lives of both producers have thereby been prolonged. The combined tonnage of both mines is now being treated without any addition to the crushing plant of the Robinson Deep, though more treatment vats have been added to deal with the increase in output. The Turf shaft of the Village Deep has been making history of late years. The vertical portion of the shaft was stopped after cutting the reef at a depth of 4100ft. from the surface. A main incline shaft was put in which finished 6263ft. below the collar, and now a sub-incline is down to 7638ft., and a winze is about 200ft. below that. It is expected to go down to 8500ft. In so deep a mine pumping expenses form a very considerable item in the total running costs. The high efficiency which is being maintained underground is attributed to the system of ventilation now in force. The fan which previously served the shaft was arranged on the 16th level, at which point it soon became inefficient, owing to the increasing depth and extent of the airways and to the difficulty encountered in short-circuiting of the ventilating current. A new fan of similar power, but of different make, was therefore installed on the 33rd level, and that step has been fully justified. The virgin rock temperature on the 41st level is 99 deg. Fah. The mean temperature of the air there is 83 deg. Fah. dry bulb and 81 deg. Fah. wet bulb, and it is expected to improve on those figures. Mining at greater depths than hitherto reached is dependent on wet bulb temperature. It is not heat that forms the obstacle, but heat-cum-moisture.

A Visit to the Works of Negretti and Zambra.

HAVING in mind a full knowledge of the range of instruments produced by the firm, it seems somewhat curious to us that the name Negretti and Zambra should be associated by most people only with meteorological instruments. Although it is perfectly true that the firm does produce a very large number of such instruments, it is not by any means concerned only with the construction of barometers, rain gauges, anemometers, sunshine recorders, and the like. In actual fact, the manufacture of meteorological instruments is only one of the lines of production in which the firm is interested. Many power plants, both on land and afloat, many manufacturing processes in this country and abroad, and many varieties of machines are controlled by the help of instruments made by it. In other words, those of the clerk of the weather are not the only requirements that influence the design of Negretti and Zambra instruments.

The facts mentioned in the last paragraph were strongly brought home to us recently when we had the opportunity to visit the works of the firm at Barnsbury. The company was founded in 1850—six years before THE ENGINEER was first published—and although the works have been very considerably extended since that date, they have always been situated in the same place. At present, about 250 hands are employed. No piece rate system is employed, the men working at an hourly rate of pay; but a bonus is distributed monthly according to the output.

MERCURY-IN-STEEL THERMOMETERS.

Of the many departments to be seen that devoted to the manufacture of mercury-in-steel thermometers is, perhaps, the most interesting. In a great variety of processes the key to success lies in a very accurate measurement of temperature. In the brewing, food-preserving, jam-making, and similar trades the tempera-

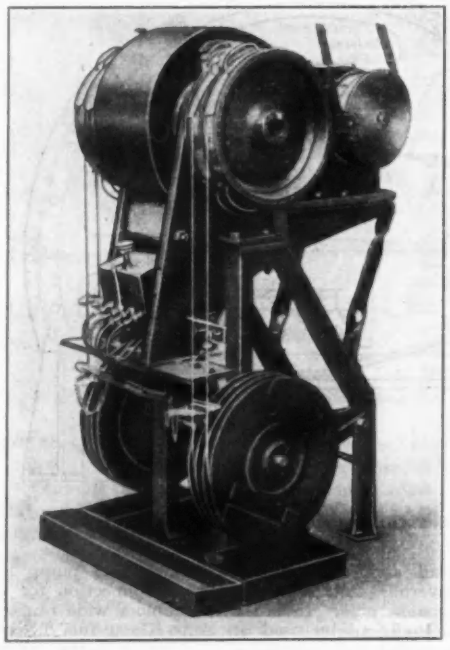


FIG. 1—CAPILLARY TUBE DRAWING BENCH

tures at certain stages must be kept sensibly constant for long intervals at some definite figure, while in other processes, such, for instance, as the hardening of certain special steels, high temperatures must be measured accurately to within 5 deg. Fah. In many cases, also, it is, if not an absolute necessity, a very great convenience to be able to mount the dial or recorder of the instrument at a distance from the point at which the reading is taken. Placing the instrument on a panel some distance from the bulb involves the problem of transmitting the effect of change of temperature without lag and without interference, over the intervening space. For such purposes the mercury-in-steel thermometer has been developed. It consists essentially of a steel bulb filled with mercury placed at the point at which it is desired that the temperature shall be measured and connected by a steel tube—also containing mercury—to a Bourdon coil which records the fluctuations. It will be obvious that great care must be taken in constructing such an instrument. In that made by Negretti and Zambra the pipe connecting the bulb to the Bourdon coil has an internal diameter of no more than some six-thousandths of an inch, and the mercury is forced into the system under a pressure of more than 1000 lb. per square inch. The instrument works by the increase of pressure due to the rise of temperature as much as by the increase of volume of the mercury, and consequently, there is plenty of power to move the needle attached to the Bourdon tube. The amount of mercury contained in the connecting pipe, or capillary, as it is usually termed, is very small in comparison with the quantity in the bulb, and not till lengths above 40ft. are encountered is any device to compensate for temperature necessary; but the instrument itself, as distinct from the capillary, is frequently compensated for temperature changes by connecting the inner end of the Bourdon coil to the pointer by means of a bi-metallic coil of suitable length. The capillary tubing is drawn down from steel pipe with a bore of $^{5}/_{32}$in. to a final diameter not exceeding 0·008in., and sometimes as little as 0·005in., in lengths up to 120ft. One of the drawing benches is illustrated in Fig. 1. With such a great reduction it is, of course, necessary to anneal the pipe several times. Before the final draft, when the pipe is still of a sufficiently large diameter, the bore is sand-blasted and subsequently blown through to remove all traces of the sand. For the purposes of making this tubing, the steel must be particularly ductile, and especially fitted for the demands of the process. The same remarks apply to the tube from which the Bourdon strip is produced. For this process steel piping with a bore of $\frac{3}{8}$in. is drawn down and finally flattened, being, of course, annealed several times during the process. Negretti and Zambra have improved the ordinary strip—Fig. 3 top—which suffers from the weakness that the stresses in the material due to dilation are concentrated at the edge of the space for the liquid, by developing a strip with a section as shown below in the figure. The stresses are in this way distributed over the narrow part of the section at A, and the edge of the space is relieved. The strip is cut into lengths and passes into the hands of a workman, who coils it on a mandrel spacing

FIG. 2—DOUBLE BOURDON COIL

the coils by winding between them a strip of thin copper, which is removed when the coil is complete. Both double and single Bourdon coils are used. The former is illustrated in Fig. 2. Beginning at the point of attachment of the needle the coil is wound outwards for the correct number of turns and then twisted diagonally over and round inwards to the centre, where it is connected to the capillary. Although finally placed side by side the two coils are wound separately at first on the same strip so that they are in tandem. The workman, then, with a rapid twist of his hands very difficult to follow, bends over the straight portion of the strip intervening between the coils and sets them side by side. Before leaving the subject of the Bourdon coil, it should be noticed that the construction is such that the pointer spindle being connected at the axis of the coil, will be given a truly rotary motion, whether or not it is supported in bearings. In actual fact, bearings are always provided, largely, however, to overcome the effects of vibration.

The bulb, which is also made of steel, is turned out of the solid on a lathe and plated, and the capillary is welded on to it. For this purpose special little bench machines are employed. In them the bulb is mounted at the centre of a table rotated by power, but controlled by a foot clutch. The Bourdon coil and the capillary are also welded together, but at this end a second short length of capillary is also welded in to provide a means of filling the system. When it is appreciated that the capillary

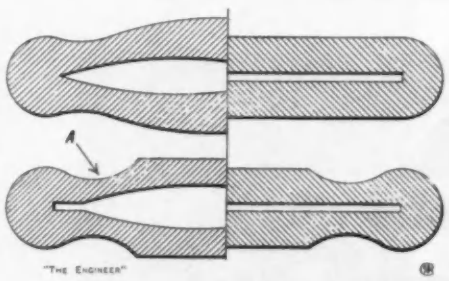


FIG. 3—TYPES OF BOURDON STRIP

bore is less than 0·008in. in diameter, it will be realised that these welding operations are delicate work and that the welder is a very skilled hand. A special welding flame, with a point hardly greater than that of a pencil, is used.

The system is not filled with mercury until the Bourdon coil, the capillary, and the bulb have all been connected together. In Fig. 4 two capillary tubes connected to the Bourdon coil can be seen. One of these forms the connection between the Bourdon coil and the bulb, while the other is only used for filling the system. The filling process consists, first, in evacuating the system entirely, and then forcing in mercury under a pressure of about 1000 lb. per square inch. Twelve instruments are filled at one time.

The capillary tube may be protected in a variety of ways, according to the purpose for which it is required. We saw it enclosed in lead or copper sheaths, while for use in aeroplanes and other purposes it may be protected by cotton brading or similar fabric which gives it the appearance of stiff insulated wiring.

Once constructed, the instrument must undergo searching tests. To begin with, of course, it is calibrated against a standard and the scale of the gauge is marked off. Ageing then takes place in a department which is illustrated in Fig. 5. In the foreground of the engraving there are to be seen two tank-like affairs in which are bored many holes. These tanks are gas heated, and the bulbs of the thermometers to be tested are placed in the holes; the bulbs of high-range thermometers in the holes at the bottom, and those of low-range instruments in the holes near the top. The instruments remain here for several days, the gas heating the tanks being turned up and down at intervals to cause each thermometer to register over the whole range. Readings are taken at intervals to ensure that no alteration of the setting of the instrument is occurring. There are to be seen in the engraving thermometers equipped with a considerable length of fabric-covered capillary for use in aircraft, self-recording thermometers, exhaust temperature instruments for use with internal combustion engines, and others provided with gauges for mounting on a panel in a power plant or the like

GLASS THERMOMETERS.

Another department deals with the marking and testing of glass thermometers. Both gas and electrically heated baths are used. A number of the latter are shown in Fig. 6. According to the range of the instrument to be marked off, water, lead, or other materials are used. Each bath contains two thermometers, one of which is a standard frequently compared with a special standard checked by the National Physical Laboratory. The standard thermometer is, of course, of a type similar to that to be marked off. In order to ensure that the liquid shall be of the same temperature throughout, it is circulated by a small pump driven by a belt from the small wheel to be seen in the engraving at the back of each bath. According to its range, the new thermometer is scratched at suitable intervals. An ordinary commercial type, 32 deg. to 212 deg. Fah. range instrument, would be marked off every few degrees, for instance. When it has been thus marked off, it is varnished and taken to another department, where the intervals are divided off on a dividing machine, which scratches away the varnish and exposes the glass for the etching process which follows. The final process which completes the instrument is the blackening of the etched lines and the removal of the

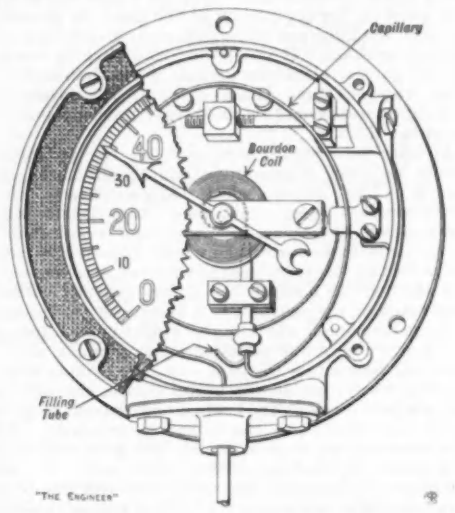


FIG. 4—CONNECTIONS OF CAPILLARIES TO BOURDON COIL

varnish. Before finally passing out of the works, glass thermometers are subjected to rigorous tests.

BAROMETERS AND KINDRED INSTRUMENTS.

Leaving, now, the subject of thermometers, we enter the departments given up to the production of barometers and kindred instruments. Although such work is closely connected with the weather, we found that the meteorological aspect was by no means more important than the industrial. A general view of the shop is shown in Fig. 12, page 212, while some idea of the instruments constructed in this department can be gained from the drawing, Fig. 7.

The instrument illustrated—a precision aneroid barometer—is a recent production. The needle is rotated over the scale by the action of two "diaphragms" acting as a couple on a movable arm. The diaphragms are exhausted, and consequently expand and contract according as the barometric pressure falls or rises. Besides doubling the power obtainable from a single diaphragm of convenient size, the arrangement also provides the advantage that the instrument is under perfect balance. With a single diaphragm an alteration of the position of the instrument or the angle at which it was held might easily cause a corresponding deflection of the needle, but the balanced arrangement provides sufficient power to hold the needle in one position, regardless of the movements of the instrument as a whole. The operation of the mechanism is easily followed from the drawing. The motion is exceptionally free and definite, as we demonstrated by descending a flight of steps for about 10ft. and observing the easily readable deflection of the needle. There was no jerk in its motion, while tapping of the glass quite roughly had no effect. The most important parts of the instrument are, of course, the diaphragms. They are of the concertina type, built up out of the necessary number of rings pressed out of corrosion-resisting, hardened and tempered steel, soldered together, first at their inner edges in pairs, and then at their outer edges to form a group or unit. No springs are incorporated in the diaphragms, which are consequently free from frictional errors.

The use of diaphragms is not confined to barometers. In Fig. 8 we illustrate an arrangement by means of which a diaphragm is used as a "detector" transmitting the pressure it "feels" through capillary tubing, similar to that used for thermometers, to a Bourdon gauge. The liquid in the system is suitable for the requirements of the gauge and the temperatures to which it is likely to be

subjected. This form of gauge is much used on aircraft to measure the lubricating oil pressure. It is of importance that the pilot should be able to observe this pressure, since its failure indicates a broken pipe connection or other fault, and serious damage to the engine may follow if action is not soon taken to remedy the defect. It will be seen that the diaphragm is surrounded by a chamber into which the lubricating oil flows under pressure. In the unlikely event of a failure of the diaphragm no oil can be lost, since it then only gains access to the gauge itself, while, even should the capillary break subsequently, the amount of oil that can leak away through the very small resulting hole is so small as to be negligible.

Another aircraft instrument is illustrated in Fig. 9.

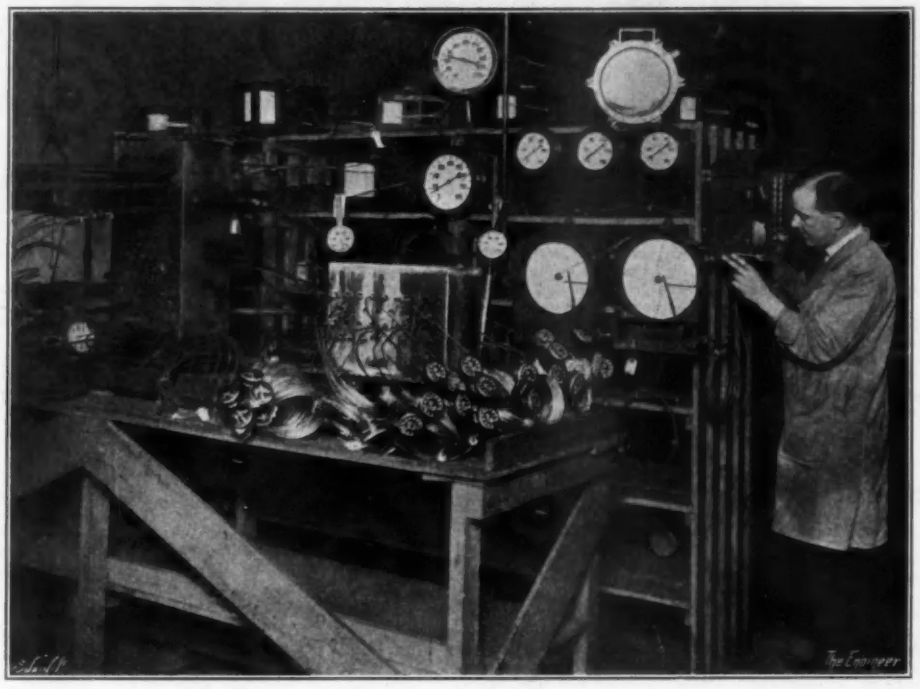


FIG. 5—THERMOMETER AGEING DEPARTMENT

It is known as a "boost" gauge, and is used on aeroplanes for measuring the pressure in the induction pipe of a supercharged engine. It is of importance to know this pressure since, at ground level, it is possible to supercharge excessively. The exhausted diaphragms are enclosed in an airtight box housing the mechanism, the dial, &c., and connected by a pipe to the point at which it is required to measure the pressure. The maximum safe pressure is marked in red on the dial of the instrument. The working of the mechanism is not very clear in the drawing, and a word or two of explanation may be welcome. An increase of pressure causes the diaphragm to collapse slightly. A link connects the top of the diaphragm to the side of a

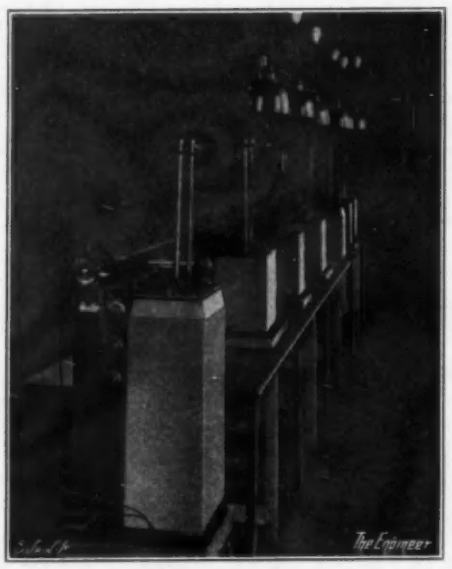


FIG. 6—THERMOMETER TESTING BATHS

horizontal shaft mounted on bearings above the diaphragm and, consequently, collapse of the latter rotates the shaft. At the other end of the shaft there is hung, on a lever, a sector rack driving a small pinion mounted on a vertical shaft. This shaft passes through a hole cut across the horizontal one and through the centre of the face of the instrument, and carries, at its top, the pointer. We saw one of these instruments under test and were much impressed by the friction-free motion when the pressure was raised and lowered.

Barometers and other instruments of a similar type are tested in a vacuum cupboard similar to that to be seen in the photograph reproduced in Fig. 10. The engraving shows a recording barograph under test. The cupboard is strongly constructed to withstand atmospheric pressure under high vacua and is equipped with a glass front mounted in a metal frame swung on hinges. The front closes on a rubber ring against which it may be tightly clamped by hand screws. On the occasion of our visit an experimental test was in progress in one of these cupboards. The instrument was of new design and was being tested for temperature effect. The air within the cupboard was circulated by a fan and directed on to the instrument and thermometers by baffles.

THE ELECTRICAL DEPARTMENT.

The liquid is not the only type of thermometer produced by the firm, and the photograph reproduced in Fig. 13, page 212, shows the electrical department. Many of the thermometers made here operate on the Wheatstone bridge principle, the reading being obtained by measuring the deflection of a galvanometer connected across the bridge. This form is well known, and in spite of certain small disadvantages, inherent to the type, has proved very reliable. Another instrument working on the same principle applied in a different manner appears to have many advantages. Instead of finding the temperature by measuring the out-of-balance current flowing across the bridge, one of the resistances is altered to bring back the bridge to balance. The alteration of the resistance is accomplished by turning a knurled wheel, the operation of which also moves a needle over the dial of the instrument. Below the dial there is situated the needle of the galvanometer reading against an edge-wise scale. The position of no deflection is marked plainly and in operation

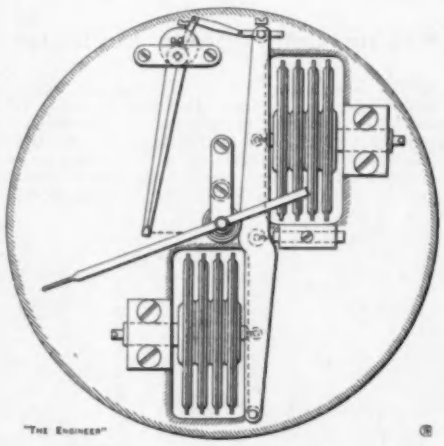


FIG. 7—PRECISION ANEROID BAROMETER

it is only necessary to turn the knurled wheel back and forth until the galvanometer needle coincides with this mark. Although somewhat complicated to describe, the instrument is very easy to use.

Besides Wheatstone bridge instruments thermo-couple thermometers are also produced, and the instruments can be made to register on edge-wise or ordinary scales, and to record the temperatures at a number of points according to the position of a switch. The impression we gained of the great variety of instruments which the firm is called upon to supply was well illustrated by a gauge intended for the measurement of the temperature of all the rooms in a large hotel. Besides giving a visual reading for each room on the depression of the appropriate switch, it could also be used to provide a record of the temperature changes in any one of the rooms.

THE EXPERIMENTAL DEPARTMENT.

Most engineering firms carry out experimental work at one time or another, but to one such as Negretti and Zambra a department set aside for experimental work is a necessity. This room is illustrated in Fig. 14. Here, besides a certain amount of routine testing, new instruments are continually being tried and possible improvements to old ones investigated. The machine shown in Fig. 11 illustrates well the lengths to which the firm is prepared to go for testing purposes. It was designed by the staff of the firm for the purpose of testing Bourdon

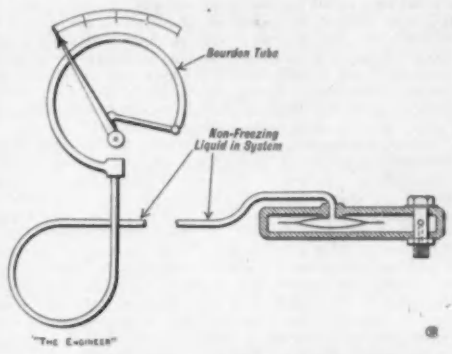


FIG. 8—PRESSURE GAUGE CONNECTIONS

tubes to destruction by fatigue. A small electric motor drives through belting and gearing a small ram pump, which forces the liquid—usually mercury—into and out of the Bourdon tube under test. A counter similar to the milometer sometimes fitted to pedal bicycles counts the number of reversals. The machine, of course, stops automatically when the Bourdon tube fails. By the help

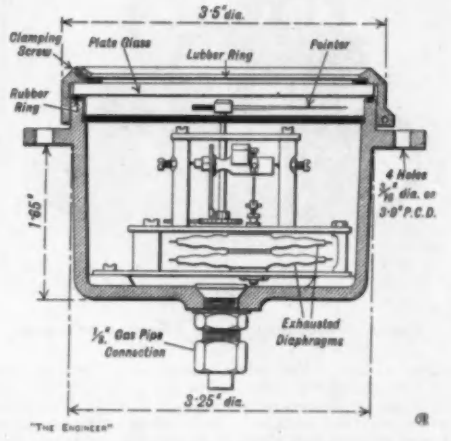


FIG. 9—"BOOST" GAUGE

of this machine the type of Bourdon tube already described has been evolved.

The making of glass thermometers is, no doubt, familiar to our readers. In Fig. 15 we reproduce a photograph showing the men at work in the department given up to the production of these instruments at the Barnsbury works of Negretti and Zambra. Most of our readers have, no doubt, at some time, like ourselves, attempted to

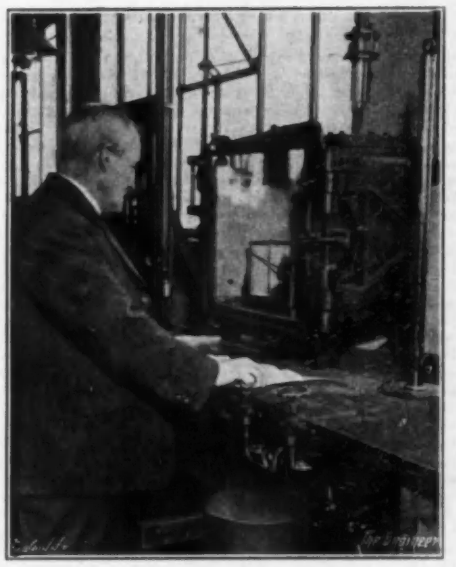


FIG. 10—VACUUM CUPBOARD

blow and to work glass. The artistry of these men who can attach to the end of the stem of the thermometer the "normal" glass bulb, and estimate, apparently by eye, the correct dimensions of the bulb not to mention forming it to the correct shape, needs therefore no stressing here. The finishing operations of marking off and testing have been described elsewhere in this article.

The firm finds itself forced to be continually investigating the merits of new designs. Many instruments very well, perhaps, in their own way, but rejected for some slight

fault, are to be seen, while elsewhere in the appropriate departments new instruments are being brought to perfection. One of these latter instruments is of considerable interest. It was devised with the object of taking a record of the temperature in a cold storage or refrigerator room on board a ship. The instrument is enclosed in a wooden box, the actual temperature being measured by an ordinary glass thermometer. A clock, also, enclosed in the box, controls a switch which closes and opens the circuit to a small electric lamp at suitable intervals. At the same time it drives rollers upon which are wound an ordinary Kodak film of length sufficient to give a long series of photographs of the thermometer. The light from the lamp is collimated by a lens and passes through the thermometer on to the photographic film, upon which the shadow of the thermometer is, of course, recorded. The box is capable of being locked up and sealed.

Another instrument which struck us as ingenious, although, apparently, it had not proved successful, was a recording barometer. Instead of repeating the movements of an exhausted diaphragm by means of a mechanism connected to the pointer, that diaphragm was fitted into a framework, an extension of which carried the pointer, the whole affair being supported on knife edges and balanced by a counterweight suitably placed. A variation of barometric pressure caused a variation in the size of the diaphragm and consequently threw the device out of balance, which was only recovered by a swing on the knife-edge. Hence, a record of the changes in barometric pressure appeared on the graph.

We were surprised to learn that there is very little made by the firm that can be constructed on mass production principles. An attempt, for instance, has been made to standardise thermometers into certain ranges, but, on the whole, customers prefer to have instruments made exactly to their requirements. In some ways fashion enters into the design of instruments. For instance, at the present day there is a tendency towards flush-mounted instrument panels, owing to their neat appearance, in spite of certain inherent disadvantages in the arrangement arising from the necessity of placing the connections somewhat inaccessibly behind the panel. There is also a preference for edgewise scales. The firm thus finds that since the outward appearance at least of the instrument is continually altering, it is only possible to manufacture by group production.

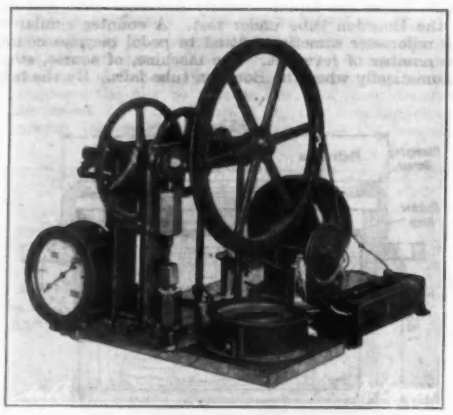


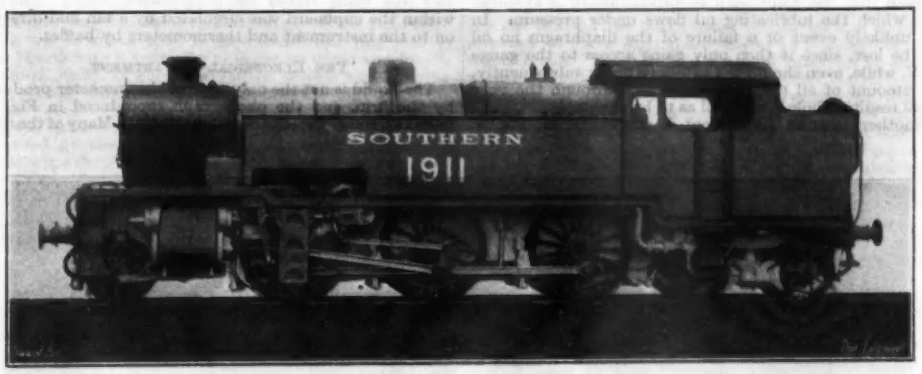
FIG. 11—BOURDON TUBE TESTING MACHINE

SIXTY YEARS AGO.

UNTIL we encountered the name of Bland William Croker in our issue of February 23rd, 1872, we had no conscious knowledge that anyone bearing it had ever existed, still less that he was one of the eminent engineers of the mid-Victorian era. Yet when he died sixty years ago it was written of him that he was one of that band of able men who had raised themselves to distinction and who, in doing so, had conferred the most solid and lasting benefits on our age and country. Reading the details of his life, we are struck less by the beneficent nature of his works than by the way in which they helped to shape history and prepare the stage for the tragedy of 1914. Croker was born in 1822 at Blandsfort, in Ireland. Choosing to become a civil engineer, he entered the office of his cousin and guardian, Mr. W. T. Clark, F.R.S. For ten years he was Clark's companion and assistant on the erection of the great bridge across the Danube at Buda-Pesth, a work which, when completed, was regarded as marking the revival of Hungary's political and intellectual history. Later, for a period of five years, he served as resident engineer on the construction of Amsterdam's waterworks. In 1857 he went to reside in Vienna, and in the service of Austria he remained to the end of his comparatively short life. In 1859 the war between Austria and Italy had assumed a very grave aspect, and it was deemed necessary to take steps to secure the safety of Venice, the central point of the controversy. The Austrian Government sought Croker's aid. For several months he worked at the Venice Arsenal, inventing, making, and laying "torpedoes," and had nearly completed the protection of the city when the peace of Villa Franca put an end to hostilities for the time being. From Venice Croker was summoned to take charge of the Zeltweg ironworks in Upper Styria, and for ten years he laboured in that post. He did much to improve the Arsenal at Pola during this period, and for that and other work he received high honours at the hands of the Emperor Franz Joseph. While at Zeltweg he introduced into Austria the manufacture of iron armour plating for ships of war. His armour contributed materially to the Austrians' success against the Italians at the naval battle of Lissa in 1866. In a broadside engagement between the "Ferdinand Max" and the "Re d'Italia," the Austrian flagship received repeated discharges without hurt, while the Italian vessel was eventually sunk. Croker's thoughts and energies were also turned towards great schemes of railway construction within the Empire. One such scheme was for a railway from St. Peters to Pola, and another for uniting the Danube with the Adriatic by means of a line passing through Sarajevo. The confessed object of these works was to bind Bosnia and Turkish Croatia morally, intellectually, and materially to Austria, and to place Austria at last in a position to govern Dalmatia.

SOUTHERN RAILWAY: GOODS TANK ENGINE

MR. R. E. L. MAUNSELL, M.I. MECH. E., ENGINEER



Southern Railway: New Goods Tank Locomotives.

THE first of a new series of three-cylinder 2–6–4 goods tank locomotives, to be known as Class "W," has just been completed at Eastleigh Works and is illustrated herewith. Four more are in course of construction, and ten are to be built at Ashford Works. These new locomotives are practically identical with the three-cylinder goods tender engines Class "N. 1," with the addition of side tanks, bunker and a trailing bogie. The side tanks with the tank below the bunker hold 2000 gallons of water, and the bunker carries 3½ tons of coal.

A powerful graduated steam brake is fitted, and can be worked in conjunction with the vacuum brake on the train when required, the brake blocks being applied to all wheels except the leading pony truck.

The cylinders are 16½in. by 28in. stroke, the coupled wheels 5ft. 6in. diameter, and the boiler pressure 200 lb. per square inch, resulting in a tractive effort of 29,452 lb., or 13·15 tons. The evaporative surface is 1525·6 square feet, the superheater surface 285 square feet, and the grate area 25 square feet. The total weight in working order is 90 tons 14 cwt., and the total adhesive weight is 57 tons 5 cwt., the ratio of adhesion to tractive effort being 4 to 1 with the tanks half empty.

They are intended mainly for the heavy goods traffic in the Metropolitan area and other short-distance goods workings elsewhere.

Moving Coil Voltage Regulators.

IN the transformer section of our annual article on "The Progress in Electrical Engineering during 1931" we referred to some moving coil voltage regulators put upon the market by Ferranti Ltd., of Hollinwood. The keynote of the design of these regulators is the elimination of all parts liable to breakdown or calling for frequent attention, for the change in voltage is obtained by varying the relative distances between a movable short-circuited coil and two fixed coils, an arrangement which avoids, on the one hand, the switchgear necessary for tap-changing and, on the other, the slip rings, flexible connections and slot insulation of the induction regulator.

As compared with the latter, the moving coil regulator has the design characteristics of a transformer. There are no windings in slots and all the coils are similar in design, construction, and insulation to ordinary transformer coils of corresponding voltage and current rating. The regulator can therefore be designed for high voltages in the same way as a transformer. Since there are no small magnetic air gaps, the mechanical forces are very much lower than in the induction regulator, with a corresponding reduction in the chattering, and consequent wear of bearings which often cause increase in noise and vibration after a few months' service.

The losses are also said to be lower than those in an induction regulator, and, further, the voltage distortion due to high flux density in core teeth is, of course, absent. Owing to the large air gap in the moving coil regulator, coupled with the low flux density in the core, the magnetising current is sinusoidal.

The essential features of these regulators—see Fig. 1—consist of two coils 2 and 3 connected in series across the supply voltage V1. These two windings are mounted at the top and bottom respectively of one limb of an iron core and another coil 4 short-circuited on itself can be moved up and down the limb between the coils 2 and 3. As the coil 4 is entirely isolated no flexible connections, slip rings, or sliding contacts are required. When this coil is at the top of the leg close to coil 2 the impedance of coil 2 is relatively small and the impedance of coil 3 relatively large. The voltage across 2 will therefore be nearly zero, and V2, the voltage across 3, will be almost equal to V1. But when the coil 4 is at the bottom of the limb and close to coil 3 the voltage across 2 will be almost equal to V1, and V2 will be nearly zero. Thus, by varying the position of the coil 4, V2 can be varied from practically zero up to the value of V1.

It is, however, only in testing transformers and similar arrangements that the full range of regulation available, *i.e.*, from zero to full circuit voltage, can be directly utilised. But if the regulator be connected across a portion of the winding of a transformer that just covers the voltage variation required, the full range of the regulator can be taken advantage of. This arrangement is shown in Fig. 2, in which connections corresponding to 90 per cent. and 110 per cent. of normal voltage are shown brought from the transformer to the regulator, which can therefore give smooth regulation over that range, *i.e.*, ±10 per cent.

An alternative arrangement of more general application is shown in Fig. 3, in which the regulator is independent of any transformer winding. The coils 2 and 3 are connected across the circuit voltage V1, but the excessive range of voltage variation available is stepped down to the required figure by placing secondary coils 5 and 6 of fewer turns adjacent to the coils 2 and 3 and connecting them in series with the outgoing line, the coil 6 being arranged to give a boost in the opposite direction to the coil 5. As the short-circuited coil 4 is moved from the bottom to the top of the limb the voltage across the coil 3 varies from zero to V1, while that of coil 2 varies from V1 to zero. If, then, the ratio of 2 to 5 and of 3 to 6 is V1/v, the voltage of 6 will vary from 0 to $-v$ and that of 5 from v to 0, so that their resultant, *i.e.*, the actual boost in the circuit, will vary from v to $-v$. If boost is required in one direction only, one of the secondary coils is omitted.

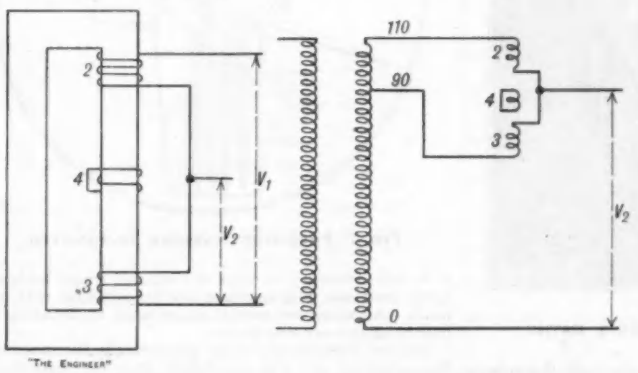


FIG. 1

FIG. 2

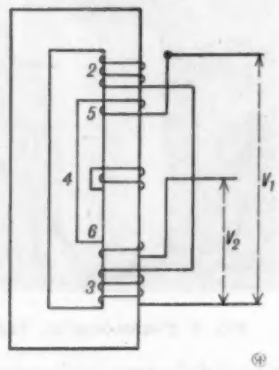


FIG. 3

Although the moving coil regulator has a larger air gap than the induction regulator, the magnetising current of the former, even in the worst case, is only a little greater, and in a few cases is even less than that of the latter. The former also has a higher reactance drop, but allowance for this is, of course, included in the range of boost given.

The chief advantages claimed for the moving coil regulator are:—Simplicity, smooth voltage change, minimum maintenance, noiselessness, negligible phase displacement, perfect wave form, and the moving coil is not subject to heavy forces.

Railway and Road Matters.

ANSWERING a question addressed to him on February 10th, the Minister of Transport said that he hoped to arrange for the extension of the use of automatic traffic signals with a number of the Metropolitan Boroughs, and that their Councils had been advised that he was prepared to consider any proposals they might submit.

THE report of the South African Railways, mentioned herein on February 4th, says that during the year 1930 the position in regard to road motor competition was, briefly, that the rapid growth of competition, characteristic of the preceding years, had been arrested. A measure taken by the railway administration towards that end was the inclusion of a clause in the forms of tender for the supply of material and stores, but the tenderers must be prepared, in the event of their tenders being successful, to have all their goods transported by railway or by railway owned road service.

THE Ministry of Transport railway statistics for the month of November last have recently been issued as a Stationery Office publication, price 2s. 6d. They show that when compared with the corresponding month of 1930 a decrease of 6·2 per cent. in the number of passenger journeys and of 10 per cent. in the receipts from passengers. The passenger train mileage was reduced by 1·3 per cent. The tonnage of freight fell by 9·1 per cent., and the receipts therefrom by 8·3 per cent. The freight train mileage was reduced by 4·2 per cent. The average train load suffered a drop from 131¼ to 125 tons, and the net ton-miles per engine hour from 457¼ to 448¾.

OUR various references of late to the desire of the railways of the United States to reduce their men's rates of pay may now be concluded by the satisfactory statement that an agreement between the two parties was signed late on the night of Sunday, January 31st. Instead of a reduction of 15 per cent. there is to be a deduction—a concession of term to the men—of 10 per cent., and the situation is to be reviewed at the end of twelve months. The companies have further agreed to do all in their power to maintain and increase railway employment. The saving will bring in about 210,000,000 dollars, and will help to rescue many individual railways from possible bankruptcy.

THE London and North-Eastern locomotive programme for the current year provides for the building of forty-two tender engines and twelve tank engines. The number of standard "Pacific" class is to be brought up to seventy-five, and will include five additional high-pressure engines for express work in Scotland. The East Anglia traffic is to have six more of the four-cylinder 4–6–0's of the "Sandringham" class, and, for the heavy mineral traffic in the Nottingham area, there are to be ten 2–8–2 heavy tank engines. For the Whitemoor hump marshalling yard two 0–8–4 tank engines are being built to which the booster arrangement for the trailing bogie wheels will be added.

THE experiments, commenced by the Great Western Railway over a year ago, in the building up of worn permanent way crossings, i.e., where the rail of a junction, crossover road or siding crosses another, by electric welding, have proved very satisfactory, and five electric welding sets are now employed in this work on the Bristol, Plymouth, Newport, Neath, and Wolverhampton divisions. An effective rail-oiling apparatus, for reducing the side wear of rails on curves, has now been devised and is being finally tested on several divisions on the Great Western before introducing it for general use. Experiments are now being carried out with various kinds of alloy steel rails, including those of manganese, chromium, copper, and titanium.

BY adopting the belt system, by which the work moves forward to the workman instead of the old method of the workman moving about the shops to the work, the E.B. railway has, says the *Indian Railway Gazette*, set up a record among all the railways of India, both State-managed and company-owned, of twenty-two days for reconditioning and overhauling locomotives, beating the record of the G.I.P. Railway by four days. Not only has there been a saving in time, but in costs, too, the figures for the E.B. Railway being the best for any broad-gauge workshop in India. The Eastern Bengal Railway is to be congratulated on its achievement for the average at the Kauchrapara workshops is twenty-three days, and in spite of the fact that the workshops were working short time, being closed on Saturdays, the actual number of days the engines were in the shops was twenty-two, and the working days fifteen only. It is gratifying to feel that engineers in India are able to keep in touch with developments in other countries by taking advantage of improved methods and to show that the results it is possible to attain in this country compare very favourably with other parts of the world.

AT about 11.30 on the night of November 3rd last the empty coaches of a passenger train from Euston were about to be shunted from the down slow line into the carriage sidings at Tring for the night, when they were run into by an express goods train from Camden to Liverpool. The coaches were protected by the home signal for Tring No. 2 box, and by the home signal and distant signal for Tring No. 1 box. The latter signal was over a mile from the point of collision, and its home signal was over 600 yards distant. The driver, who was reported as a man with an excellent record, attributed his failure to see the signals in question to (1) steam and smoke momentarily affecting his vision, and (2) loss of location. Colonel Mount, whose report on the accident has recently been issued, has doubts as to the validity of the first excuse, but, as to the second, he says that it is significant that the occasion was the first time the man had driven a train between London and Nuneaton, and he had never fired over the road. The inspecting officer says that he has no recommendations to make, but it remains to remark that automatic train control would undoubtedly have prevented the accident, but, on the other hand, it was possible that the brilliant indications of a colour-light signal would have afforded adequate means for arresting the driver's attention.

Notes and Memoranda.

A STUDY of the booklet concerning the steep hills of Great Britain, issued by the Automobile Association, taken over a period of years, shows that the contour of our roads is gradually changing, while in several instances alternative new roads have been constructed to avoid steep and dangerous gradients.

DIES for stamping and drop forging, made of nickel-chromium cast iron, are becoming increasingly popular in America. They can be machined without trouble and require no inserts at edges and corners. A table published in the *American Machinist* of February 13th gives appropriate alloys for various purposes.

AN unusual bridge has been erected by Sir William Arrol and Co., Ltd., Glasgow, over the river Gryfe, in Renfrewshire. Its outstanding feature is that the flange plates, web plates, and stiffeners of the main girders are welded together by the electric arc process instead of riveting. The bridge is said to be the first application of electric arc welding in Great Britain to road bridge construction.

ALUMINIUM powder consists essentially of minute flat particles which are prevented from welding together during the stamping process by which the material is produced by the addition of a small quantity of grease, and a further quantity of stearin is usually added in the final polishing process, which is done inside ribbed cylinders fitted with revolving brushes, with the result that the final powder is highly resistant to tarnishing.

IN a paper by Mr. H. S. Lamburd, of New Zealand, read before the Junior Institution of Engineers on February 5th, detailed particulars were given of the hydro-electric scheme now under construction at Waitaki in the South Island on the river of that name. The full scheme will comprise five 16,666-kVA alternators driven by Francis mixed flow reaction turbines, each developing 23,000 B.H.P. Two units are at present being installed. The turbines run at 125 r.p.m., and the total head of water is 70ft.

FOLLOWING discussions between the Post Office and representatives of the wireless trade, it has been agreed that a dealer may supply a wireless set "on approval" for a period not exceeding fourteen days without covering it by a wireless licence, provided that he keeps a record—which should be open to inspection, if required, by an authorised officer of the Post Office—showing the name and address of the prospective purchaser, together with the dates of supply and of recovery or sale as the case may be.

AN interesting little hydro-electric plant has recently been constructed in Wales by Gilbert Gilkes and Gordon, Ltd., for Mr. W. H Mappin, of Ynyshir Hall, Glandyfi. It takes advantage of a fall of about 40ft. on the river Einion. There are two turbines, of 22 and 11 H.P. respectively, on one shaft, with a 20-kW English Electric D.C. dynamo between. Thus the plant can deliver 11, 22, or 33 H.P. according to the water available. The current is transmitted to the Hall, some farms and two adjacent villages at a pressure of 230 volts by bare overhead wires on wooden poles. The flat-rate charge to the villages is 9d. per unit.

IN the course of a speech at the annual dinner of the Glasgow University Engineering Society, Mr. J. S. Muirhead, Secretary of the Glasgow University Court, urged that "There must be that training in the world outside, the practical training that the University could not give, and though University experience fortified a man for that, he had to go through the mill before he attained to full values. Scottish industry," he said, "was suffering some disadvantage because of its previous pioneering, the plant used at that stage having now become obsolescent compared with that of nations which had a later industrial development."

THE British Consul-General at Izmir, Smyrna, reports that the Izmir Municipality is offering prizes—£T4000 first prize, £T1000 second prize—for designs for waterworks for the supply of water to a neighbouring suburb. Such designs should include estimates for the work, which would not necessarily be entrusted to the prize-winner. Participants should be in possession of a British diploma and British participation would be welcomed. Specifications, costing £T10 in Turkish or £T15 in French—£T1 equals approximately 3s.—can be obtained on application to the Izmir, Smyrna Municipality, Izmir, Turkey. The competition will close on May 31st next.

ACCORDING to a recent issue of the *Moscow News*, the Stalin turbine works of the Soviet Government in Leningrad last year manufactured turbines having a capacity of 702,000 kW, as against 420,000 kW called for in the Five-Year Plan. The output included the first turbine of 50,000-kW capacity built in the works. The generators for use with the turbines were constructed at the Electrosila works in the same city, where the electrical machines for three large steel rolling mills were also built. The Sevcabel concern is credited with the production last year of the first 120,000-volt cable, while the electric concern began the production of portable electric welding machines. The Svetlana produced a 50-kW radio valve, and the Krasnaya Zaria a new type of telephone and an improved apparatus enabling several conversations to be carried on simultaneously over the same cable.

THE necessity for the installation of an electro-magnetic device for extracting tramp iron from ores, before they go to the milling establishment, is emphasised by some remarks made by Mr. G. Hildick-Smith at a meeting of the South African Institution of Engineers. He said that at the Nourse Mines the average quantity of steel extracted from the ore in this way amounted to 0·1 lb. per ton of minus 1¼in. ore, or 150 lb. daily, 50 lb. of which is mixed scrap and 100 lb. broken drill steel. The effect of this separation on the duty of the 180 stamp mill has been to increase the crushing capacity by 100 tons per day, on account of the improvement in stamp running time by the elimination of broken screens and better crushing due to there being no steel between shoes and dies. In addition to the 150 lb. of steel extracted from the fines belt, it is noteworthy that approximately 250 lb. of scrap iron and steel are daily taken off the sorting belts.

Miscellanea.

A NEW reservoir with a capacity of 1000 million gallons is to be constructed to augment Bristol's water supply.

A FACTORY for the production of fractional horse-power electric motors is being put up in Toronto by the Wagner Electric Manufacturing Company.

THE pumping station at Point St. Charles is to be extended by the addition of six new pumps. The scheme is estimated to cost 580,705 dollars.

A DIRECT telephone connection over Canadian lines is now available from Halifax to Vancouver. The distance is 4263 miles and there are twenty-two repeater stations

THE overhead electric cables of Montreal are gradually being put underground, and it is estimated that 5,000,000 dollars will be required for the purpose during the next three years.

IT is expected that the direct Bombay-Calcutta telephone connection will be ready for service in about one month's time. Repeater stations are being arranged at four intervening places.

DURING last year the output of gold from the Witwatersrand amounted to 10,355,181 oz., as compared with 10,245,786 oz. for the previous year and 9,980,713 oz. for 1929. The new output is a record for the district.

THE tonnage of French ships laid up in the ports on January 15th was 768,000, an increase of 177,185 tons as compared with the tonnage in October, 1931. In the port of Havre alone there are more than a hundred ships for passengers and cargoes laid up.

AN oil depôt with tanks having a total capacity of 10 million gallons is to be put up by the Shell Oil Company at Hamilton, Ontario. A new tank steamer, built on the Tyne, has already been put in service for carrying oil from Montreal to the Great Lakes.

IT is claimed in the *Engineering News-Record* that the rate of progress of the tunnels for diverting the Colorado River at the site of the Hoover Dam represents a record. It is announced that these four 56ft. diameter tunnels are being advanced at the rate of from 230ft. to 260ft. per day.

THE present year is the centenary of the production of the first successful steel nib penholder for manuscript. The production of this little instrument, of so much importance in the world to-day, was only possible through the ingenuity of engineers, and it has completely revolutionised penmanship.

SHINGLES, for roofing purposes, to the value of 9,423,363 dollars were cut in Canada in 1929, according to official returns issued by the Dominion Bureau of Statistics, working in co-operation with the Forest Service Department of the Interior. Almost 99 per cent. of these shingles were made of cedar.

THE Government of Southern Rhodesia, in order to encourage the manufacture in that Colony of power alcohol from locally grown vegetable products for petrol blending purposes, has decided to grant a substantial rebate of duty on blended petrol containing home-made power alcohol of the required standard of purity.

THE Council of the Iron and Steel Institute has this year awarded the Bessemer Gold Medal to Professor Henry Louis, M.A., D.Sc., in recognition of his distinguished work in the fields of mining and metallurgical science. The following changes on the Council have taken place:—Mr. Arthur Dorman has been elected a Vice-President, and Captain H. Leighton Davies, of Guest, Keen, Baldwins, Ltd., and Dr. A. McCance, managing director of the Clyde Alloy Steel Company, have been elected members of Council.

TOTAL production of whale oil throughout the world in 1931 is estimated by an Oslo correspondent of *The Times* at 5,613,675 barrels, of which 3,289,880 barrels were produced by Norwegian expeditions. During last summer the production of whale oil was very restricted, the total quantity being hardly more than 60,000 to 70,000 barrels. Present prospects for this important trade must be considered very uncertain; over-production of whale oil is still very pronounced, and large quantities not yet disposed of are still being stored.

AN experimental loading of tar, from railway tank wagons to a tanker steamer, was recently made at Tyne Dock by the L.N.E. Railway. The tank wagons, which contained tar already heated so that it was fluid, were shunted up on to some staithes and the tar allowed to run out of the drain cocks into troughs arranged between the metals. The tar then flowed into a catchment tank and thence, by a flexible pipe, into the steamer's tanks. The height of the rails above water level was about 30ft., and 350 tons of tar were loaded in 8½ hours.

ACCORDING to the National Federation of Iron and Steel Manufacturers, there were seventy-six furnaces in blast at the end of January, a net increase of six compared with the number in blast at the end of December. The production of pig iron in January amounted to 332,400 tons, compared with 330,600 tons in December and 337,200 tons in January, 1931. Production included 82,400 tons of hematite, 126,900 tons of basic, 103,100 tons of foundry, and 12,100 tons of forge pig iron. The output of steel ingots and castings amounted to 429,700 tons, compared with 425,400 tons in December and 402,200 tons in January, 1931.

OPPOSITION to the development of the St. Lawrence River for power and navigation is expressed by the Quebec Legislature in a resolution adopted by a vote of 54 to 7 on January 14th. Adoption of the resolution followed active discussion in which the Premier, Mr. Taschereau, stated that the people of Quebec were opposed to taxing themselves to develop power which they did not need or to build a navigation canal which will ruin the railways of the country. Negotiations looking towards a treaty between United States and Canada, are, says the *Engineering News-Record*, making good progress, according to reports from Ottawa. The Dominion Government is stated to have conceded to the Province of Ontario complete jurisdiction over the development of power.

THE BARNSBURY WORKS OF NEGRETTI AND ZAMBRA

(*For description see page* 208).

FIG. 12—ASSEMBLING BAROMETERS AND KINDRED INSTRUMENTS

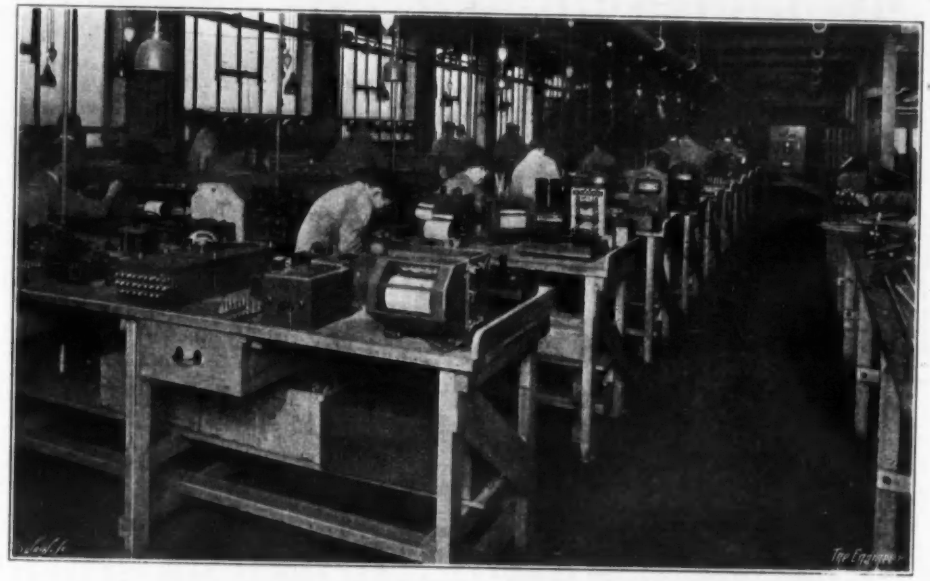


FIG. 13—ELECTRICAL INSTRUMENT ASSEMBLING DEPARTMENT

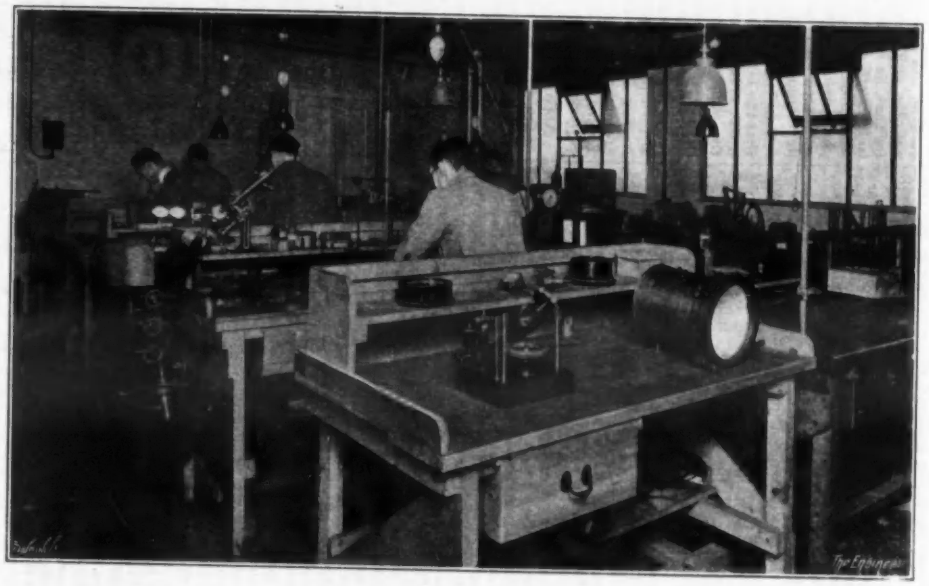


FIG. 14—EXPERIMENTAL DEPARTMENT

FIG. 15—GLASS BLOWING FOR THERMOMETERS

The Engineer

FEBRUARY 19, 1932.

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DEATH.

ON February 17th, ERNEST WILSON, M. Inst. C.E., M.I. Mech. E., Wh. Sc., Emeritus Professor of Electrical Engineering, at King's College, London.

RAILWAY CRITICS.

LAST year the railways of Great Britain transported, over greater or less distances and more or less frequently, some thirty to forty million persons. Ten million of them were too young to mind, eight million were women who care for none of these things; the remainder was composed of adult males, of whom every single one felt himself justified in criticising the company which served him and the complete railway system of this island! There may be some "terminological inexactitude" in our figures; if they are challenged we shall not defend them. But we shall defend our statement that all males who travel upon the iron road deem themselves justified in criticising its management and methods. It rarely occurs to the "man-in-the-train" that there are things in the organisation and operation of railways about which he has never heard; that railways have grown into what they are by a continual elimination of the unfit and its replacement by something better; that the handling of the affairs of such enormous undertakings is a matter for experts; or that the railways are hampered on the one hand by Acts of Parliament and on the other by physical conditions which cannot be mastered and altered "overnight." If the difficulty of the problems with which the railways have to contend were more widely known, these critics might abate their censure and display more sympathy with a public service which is yet unequalled in magnitude. We suggest, seriously, to the four companies that, in order to counter ill-informed criticism, they should print and distribute by the million a circular setting forth in language which the non-expert could follow a few of the principal factors which enter into railway organisation and management. It might be hoped that when the public saw the complexity of the problems it would begin to think better of the railways, and would, perchance, admit that the excellence of the work they do outweighs a million times the defects which make them something less than perfect.

Passing by all minor carpings, we note that the main butts of present-day critics are the locomotive itself and the competition of the roads. We suspect that the assault upon the steam locomotive is not completely disinterested. There is no more able propagandist in the world than the electrical industry. The ardour of its individuals is only equalled by the competence of its organisations. It has almost made the world believe in Electricity for Everything. Who will assert that, in its advocacy of the electrification of railways, it is wholly uninfluenced by the fact that it would profit considerably by the conversion? Again, when we see the oil-engined locomotive praised unduly, we may be forgiven for suspecting that the internal combustion engineer is not far away, and that possibly an oil company is round the corner. Whilst they are, obviously, in a position to provide useful information and the value of their advocacy is not in doubt, we submit that neither the electrical industry nor the oil engine industry nor the oil interests are competent to express a conclusive opinion. The railways know more about their affairs than anyone else, and it is their views that are worth having. And when we turn to them, what do we find? We find that for certain purposes and under certain conditions electrification is adopted—not just because it is the latest thing, but because, for the said purposes, and under the existing conditions, it is more economical than steam operation. By economical we mean much more than a mere reduction of the fuel bill. The fuel bill of railways, though great in itself, is, in fact, not a large item in the total cost of railway operation, any more than it is in the supply of electricity; no railway would hesitate to spend more on coal, or oil, or electricity if it could thereby increase its profits. With regard to the oil-engined locomotive, it is sufficient to say that every railway in the land is watching it with interest. Not one of them is indifferent to it. But, as a contributor showed in a notable article in our issue of January 29th, 1932, there is a great deal of ground to be covered before the internal combustion locomotive can compete with steam or electric engines. It may come in time, bringing with it the invaluable quality of independence possessed by the steam engine, but lacked by the electric locomotive, with the high thermal efficiency that accompanies internal combustion. But with the present limitation to three or four hundred horse-power, it is not a "practical proposition" for general main line operation. In his Friday Evening Discourse at the Royal Institution last week Sir John Cadman estimated that if "the British railways turned to oil their present work, which consumes 13 million tons of coal a year, could be done on about 1½ million tons of oil." We should be interested to see how Sir John arrived at such a rosy figure to put before the public. It might be reached by crediting oil with 20,000 B.Th.U. per pound, and locomotive coal with only 12,000, and then assuming that the oil-engined locomotive was five times as efficient as the steam locomotive. We do not think that such figures could be seriously advanced. It is true that the steam locomotive does not convert much more than five to six per cent. of the calorific value of its fuel into tractive effort, but no one could claim that the oil locomotive, with the necessary transmission gear, would be able to approach its bench thermal efficiency so much more nearly than the steam engine can that five times as much useful work would be done at the draw bar per pound of fuel. Moreover, the present price of fuel oil is nearly four times that of railway coal, and it is not a national product. Sir John might have added, too, that the oil-engine locomotive would cost approximately twice as much as a steam engine of similar power. That difference, amounting, let us say, to three thousand pounds sterling, would pay for a deal of coal.

Much of the criticism of our railways is based, as we have endeavoured to indicate, on lack of information about the numerous factors which enter into their organisation and operation, much also upon the over-sanguine claims of the advocates of systems of traction other than steam. The fact is that the railways of Great Britain are not nearly as bad as they are painted. They are at least as progressive as any in the world. They are facing at the moment great difficulties, owing to the diminution of trade and the competition of the roads. On the latter subject we may speak at a later date, when the promised reply of the road interests to the memorandum addressed by the railways to the Minister of Transport is available. For the moment, we will do no more than deprecate that form of criticism which appears to hold the railways up to censure because they have been unable to arrest the coming of a new form of transport. For certain purposes road transport has unquestionable advantages; advantages which the railways can and could do nothing to nullify. It is a new force in the world, and this country is not alone in feeling the pressure which it exerts upon its predecessors. America and Germany are just as much concerned about its influence upon their railways as is Great Britain. The statesmen of all countries will find their skill taxed to its limit in the search for a plan that will make the best of both means of transport without doing injury to either.

D.C. to A.C. Change-over Problems.

APART from the work that is being done in the way of re-equipping electrically operated factories in order to bring about the standardisation of frequency, works that were originally driven by D.C. motors are being equipped with A.C. machines or with converting plant to enable them to take an A.C. supply. The problems involved in changing over were recently dealt with in a paper read by Mr. H. Nielsen before the Institution of Engineers-in-Charge, which, judging by the discussion, was highly appreciated by the members. The first question that arises is whether all the motors should be changed, or whether the incoming current should be converted into D.C., so that the original installation may be retained, but to this question no general answer can be given. The age and condition of existing plant, cables, and switchgear may be determining factors, and the question of whether D.C. motors are best suited for driving the machinery must also be taken into account, although Mr. Nielsen considers that, generally speaking, installations of 250–500 kW capacity should be changed over completely. In discussing the larger installations which call for an examination of the alternative method of converting the current, Mr. Nielsen emphasised the importance of providing switches of ample rupturing capacity, a matter which, apart from any question of changing over from D.C. to A.C., has brought trouble to large consumers connected up to the "grid." As Mr. Scott Ram explained in the course of the discussion, switchgear has sometimes been blown up after a change over to high-capacity plant has been made, and whole sub-stations have been destroyed, because the rupturing capacity of the switchgear was inadequate. But a large amount of research work is now being done on circuit breaking, and a statement which appears in the eleventh annual report of the British Electrical and Allied Industries Research Association is encouraging. "A new form of baffle attachment," it is stated, "has been developed and tested during the year, which will enable the rupturing capacity of existing types of circuit breakers to be materially increased without increase of overall dimensions, a consideration of first importance to those authorised undertakers and consumers who find that growth of plant necessitates a heavier demand on their switchgear, and who without such devices would have to undertake expensive and difficult reconstructions."

From this important matter of providing suitable main switchgear, Mr. Nielsen turns to the question of converting the current on the consumers' premises, and considers the merits and demerits of different types of apparatus for the purpose. With rectifiers, or at any rate with those designed for the pressures commonly applied to the terminals of electric motors, he has little sympathy, and dismisses them in favour of the various forms of converting machines. That the efficiency of low-voltage rectifiers is lower than high-voltage rectifiers is, as Mr. Nielsen says, true, but up to the present many more rectifiers have been made for 500 volts and less, than for 1500 volts and over. Nor will makers of glass bulb rectifiers agree that the average life of the bulbs is three years. The statement seems to have been based on rather unfortunate experience, for users of these rectifiers generally find that the life is considerably longer than that mentioned. In the City of London forty glass bulb rectifiers have been in service since 1925, and so far only one has been replaced; whilst at Notting Hill twenty-four bulbs have been in service since 1924, and the first replacement was made a few days ago. Certain insurance companies, we are told, will insure a glass bulb valued at £75 at £2 10s. per annum for five years. We hold no brief for any type of converting plant. Rotary converters, motor converters, and even relatively low efficiency motor generators may prove to be desirable, but the statement that low-voltage rectifiers have hardly come into their own can scarcely be supported by facts. As the converting method of giving a supply to a factory is often the simplest and cheapest method of dealing with the problem, supply companies and authorities which undertake the work when a

change-over is enforced are very apt to adopt it, but it does not follow that it is always the most advantageous scheme. No converter or rectifier will work without losses, and to make the change satisfactory from the consumer's point of view, metering really ought to be done on the D.C. side. The scheme of changing over all the motors also entails the re-designing of the wiring system, although it may be possible to save the lighting wiring. Motors and starters must be selected with care to suit the individual drives. Nothing is more fatal to industrial electrification than the use of motors with unsuitable characteristics for the work that has to be performed. The squirrel-cage motor cannot be employed universally, any more than a shunt D.C. motor can. Where series or compound motors have been used for drives requiring heavy starting torques, it is pretty certain that a slip-ring motor will be required, although it is surprising what may often be done with the modern double-cage squirrel-cage machine.

We have touched upon but a few points in Mr. Nielsen's paper. Among other problems which arise when changing over to A.C. are those concerned with power factor correction and speed control, both of which were briefly considered in a leading article published in our issue of December 4th of last year. There is no dearth of published information on the principles and characteristics of different types of electric motors, but experience in the electrification of factories is what really counts. Those accustomed to that work have little difficulty, we fancy, in deciding whether they require a simple squirrel-cage, double cage, slip-ring, or other motor for a given job or a straight-on, star-delta, or auto-transformer starter. But while the problems involved in electrifying some works may be simple, owing to the special nature of the machinery, in others more expert knowledge may be essential. There are, of course, engineers who see no justification for the use of A.C. at all, but they seem to overlook the fact that the days of D.C. generation for public supply purposes are gone. The generation of electricity on a large scale and its transmission at high pressure necessitates the use of alternators which enable cheap H.T. supplies to be given to large consumers. Under the modern system of generation, D.C. distribution necessitates costly converting sub-stations, for which it is often difficult to find suitable sites, and which must inevitably increase distribution costs. Although it may be many a long day before all the D.C. distribution systems disappear, if ever they do, the obvious course to pursue is to avoid the perpetuation of D.C. distribution wherever possible, and to change over to A.C. whenever financial considerations permit.

Waterloo Bridge.

AFTER no less than eight years of discussion, the London County Council has decided to destroy Rennie's Waterloo Bridge and replace it entirely by a new structure. To the younger generation of engineers that may not appear as an act of vandalism, but to the older who regard the bridge as the monument of one of their most illustrious brethren, it seems almost as sacrilegious as the defacement of a tomb, whilst to all who have a feeling of artistic fitness it represents the destruction of an architectural masterpiece. With the regrets of both engineers and architects we associate ourselves, and all the more strongly because we are far from convinced that the decision to carry six lines of traffic across the river at an already congested centre will not cause grave inconvenience. That decision became, we admit, almost inevitable when, in October last, owing to the financial position, the erection of a new bridge at Charing Cross was, to all intents and purposes, postponed *sine die*. The resolution of the County Council has, in fact, been forced upon it, and we must account it a stroke of ill fortune that the famous structure should have given way at that very moment in her history when London is least able to bear the burden of a magnificent but extremely costly scheme for dealing with cross-river traffic. But whilst deploring the necessity, we are not amongst those who, in praising the works of the past, aver that the present is incapable of producing others of equal excellence. Concerning the ability of the firm of civil engineers—Messrs. Rendel, Palmer and Tritton—which has been entrusted with the design of the engineering elements of the new structure, there is no possible question. That the work they do will prove more enduring than that of Rennie is beyond doubt. In the selection of Sir Giles Gilbert Scott to design the bridge the Council has done wisely. Of all civic structures a great bridge over a famous river needs the repose and majesty which accompany the severity of classical designs, and Sir Giles, we doubt not, will impart this quality to his work. Rennie's bridge is not famous alone for its own merits, but for the happiness with which, whilst differing, it blends with the stately group of buildings beside it. We may take it that no civic modernist will ever have the brazen hardihood to suggest the destruction of Somerset House to make way for modern office blocks. That House will stand as long as the hand of Time permits, and as the New Waterloo Bridge must rest for centuries beside it, one may hope that it will dwell in the same artistic harmony with its neighbour as its predecessor has done for more than a century.

To What Base Uses—

WE have caught wasps in a trap, the shape of which was reminiscent of a hot air balloon. Flies can be ignominiously engulfed in the stickiness of a fly-paper. Bugs, moths, beetles, and lesser insects can be suffocated by various powders. In short, man has found protection against most of the insect ills of life. But not against all. The mosquito—save in limited areas protected by means which are not universally applicable—still parades the atmosphere; still lives to "ping" around our heads as we lie sleepless and wary on our beds during long, hot summer nights. No trap has been devised for this noxious pest. Powders are powerless against it. This insignificant scrap of life has forced man to take cover behind mosquito netting. Neither the naturalist, the zoologist, nor the scientist has been able to provide a panacea, and the insect still invades our homes, seeking whom he may devour. Great, however, are the powers of engineering! A remedy is at last forthcoming to rescue suffering humanity. In the laboratory directed by Professor Elihu Thomson, of the General Electric Company, in America, a furnace has been fusing quartz for the construction of an astronomical mirror. The furnace is electrically heated, and the hum given out by the 60 cycle current passing through the heating coils has proved overpoweringly attractive to thousands of mosquitos. From far and near susceptible male mosquitos, believing that they heard the hum of enchanting females, have flown into the laboratory and died in their thousands upon the covers of the furnace. The question whether such an explanation of the arrival of so many insects might be the true one has been placed before Professor G. H. Parker, of the Department of Zoology of Harvard University, who accepts it as, at least, plausible. Female mosquitos, it seems, do hum to attract males, which are themselves silent. Evidence is forthcoming that even to human ears the hum produced by 60-cycle current is identical with that given off by the female mosquito. It is envisaged that small electro-magnetic machines could be constructed having this invincible attraction for the male mosquito, which might draw that insect to his death by drowning, by dessication, or by shock. Though the male mosquito is comparatively harmless, does not hum, and does not bite, there can be little doubt that if he is destroyed in sufficiently large numbers the egg-laying powers of the female must suffer, and the mosquito population be thus much diminished. Even the possibility that the whole race of such insects may be exterminated by a proper use of the principle is not lightly to be rejected. It is only necessary to provide for a time an army of electric machines humming at a frequency of 60 cycles. Unfortunately, for this country, the discovery has come too late. Development of the National Electricity Scheme and the "Grid" has gone too far. We can hardly be expected to redesign the whole to work at a standard frequency of 60 cycles instead of 50, and frequency changers are costly things. Suffering under this disability we may thank Heaven that the "skeeter" does not really enjoy our climate, and we may be fortunate enough to find that the common female gnat has a 50-cycle song, and so accommodates itself to destruction by our standardised frequency.

Obituary.

SIR ARTHUR DUCKHAM.

A VERY prominent figure in gas engineering circles has been removed by the death of Sir Arthur Duckham, which took place on Sunday last, February 14th, at his home at Ashstead, in Surrey. Sir Arthur was born on July 8th, 1879, and he was therefore only in his fifty-third year at the time of his death.

Arthur McDougall Duckham was the son of Mr. F. E. Duckham, M. Inst. C.E., of Blackheath. He was educated at Blackheath School, thereafter being apprenticed to the late Sir George Livesey at the works of the South Metropolitan Gas Company, and whilst serving his time attended engineering classes at King's College in the evenings. His connection with Sir George had a lasting influence on the remainder of his career, for the rest of his life was devoted largely to the solving of problems connected with the carbonisation of coal and with questions of chemical engineering related thereto. While with Sir George he paid much attention to carbonisation practice and to furnace design. When out of his time, in 1899, he obtained a position as assistant engineer at the Bournemouth Gasworks. There he continued those studies, and, as a result, elaborated, in conjunction with Colonel Woodall, the chief engineer of that establishment, a system for the continuous carbonisation of coal. He, in fact, resigned his position at Bournemouth in order to exploit that invention commercially, and, later, with Colonel Woodall, founded the firm of Woodall and Duckham, to put it, and other inventions of his devising, on the market. After weathering some hard times, the venture had a great success, and the company became noted for the excellence of its products. Subsequently he became identified with many other companies, including the British Benzol and Coal Distillation, Ltd.; British Furnaces, Ltd.; the British Magnesite Calcining Company, Ltd.; Alexander Duckham and Co., Ltd.; the Leatherhead Gas and Lighting Company; Peco, Ltd.; the Thermal Industrial Chemical (T.I.C.) Research Company, Ltd.; and with a number of colliery companies. He was also Chairman of the Standing Committee on Mineral Transport.

During the war Sir Arthur led a particularly busy life. He became Deputy Director-General of Munitions Supply, being created—in 1917—Knight Commander of the Bath for his labours in that office. Later, he became Chairman of the Advisory Committee of the Ministry of Munitions, and still later, towards the end of the war, was made a member of the Air Council and Director-General of Aircraft Production.

Very soon after the war, Sir Arthur, as a member of an allied industry, was appointed to serve on the Coal Commission, which was presided over by Mr. Justice—now Lord—Sankey. In that connection he presented a minority report, signed only by himself, in which, while he agreed to the State ownership of mineral rights, he expressed himself as being absolutely against the national ownership of mines. Such a step, he considered, could result in nothing but calamity. His proposal was that all mineral rights should be acquired by the State and controlled by a Ministry of Mines.

His great abilities having become officially recognised during his association with Government Departments, Sir Arthur was invited—when Mr. Bruce, the then Prime Minister of Australia, asked the British Government to send out a Commission to inquire into trade opportunities of that country—to act as Chairman of that Commission. The other members were Sir Ernest Clark, Sir Hugo Hirst, and Mr. D. O. Malcolm. On the completion of the inquiry he was created G.B.E.

Sir Arthur was, at the time of his death, serving as Deputy President of the Federation of British Industries, and was this year to have become the President of that body. He was, for some time, Chairman of the Advisory Committee appointed under the Development (Loan Guarantees and Grants) Act of 1929, and was, for two years, President of the Institution of Chemical Engineers, of which he was a founder-member. He was also President of the Society of British Gas Engineers. By reason of his office of Chairman of the Committee on Mineral Transport, he was appointed to serve on the National Fuel and Power Committee and was also a member of the Standing Committee on Fuel Economy.

WILLIAM HENRY WATKINSON.

WE regret to have to put on record the death of Mr. W. H. Watkinson, Emeritus Professor of Engineering at Liverpool University, which took place at Bromborough, Cheshire, on Sunday last, February 14th.

William Henry Watkinson was born at Keighley on May 17th, 1860. He served a five years' apprenticeship in an engineering works, and was for some time thereafter engaged on experiments in connection with the design of gas engines, electric generators, &c. In 1882, at the age of twenty-two, he went to Glasgow University, where he attracted the special attention of Sir William Thomson, afterwards Lord Kelvin. As a result, he was appointed to serve under the latter and the late Professor Fleming Jenkin in the manufacture and laying of two Transatlantic cables during the years 1884 and 1885. On returning to Glasgow he won the Thomson Research Scholarship, which he held from 1885 to 1888, and became one of Sir William Thomson's laboratory assistants. In 1886 he also won a Whitworth Scholarship.

In 1888 Mr. Watkinson was appointed Lecturer in Engineering at the Central Science School at Shef-

field, a position which he held until 1893, when he returned to Glasgow in order to occupy the Chair of Engineering in the Glasgow and West of Scotland Technical School. In 1905 he was invited to become Harrison Professor of Engineering in Liverpool University, and he continued to fill that post until the termination of his active professional career in 1925—twenty years later.

By a colleague who served with him at that Institution, he is described as being one of the most active members of the Faculty, and as having been responsible for much of its development. He played an active part in the movement which ended in the founding in 1912 of the Harrison-Hughes Engineering Laboratories at the University, which were erected by the munificence of Mr. J. W. Hughes and Messrs. Fenwick and Heath Harrison. Besides his professorship, Mr. Watkinson was also Director, during his term of office, of the Walker and of the Harrison-Hughes Engineering Laboratories. He was also largely concerned in the initiation of the Alexander Elder Chair of Naval Architecture and the Robert Rankine Chair of Thermo-dynamics at the University. As an indication of his firm belief in the value of laboratory work, it may be mentioned that, when a fund was raised as a testimonial to him on his retirement, he requested that the money should be employed to endow a prize for the best work done in the laboratories by a student.

Professor Watkinson was a member of the Institution of Civil Engineers and of the Institution of Mechanical Engineers, of which he was at one time a Member of Council as Chairman of the North-Western Branch. He was also a Past-President of the Liverpool Engineering Society, on the Council of which he served for some twenty years. As an inventor his name is identified with developments in connection with air heaters, superheaters, and internal combustion engines.

MR. J. D. TWINBERROW.

WIDESPREAD regret will be felt at the death of Mr. J. D. Twinberrow, which occurred suddenly at Bickley on Wednesday, February 10th.

James Denis Twinberrow, who was destined to have an extraordinarily diversified career, was born in 1866. He received his scholastic education first of all at Bedford and then at Armstrong College, Newcastle-upon-Tyne. He served his apprenticeship in engineering at Stratford under the late Mr. T. W. Worsdell when the latter was Locomotive Superintendent of what was then the Great Eastern Railway. Before the term of his apprenticeship had expired, Mr. Worsdell was, early in 1886, appointed Locomotive Superintendent of the then North-Eastern Railway, and young Twinberrow served for the remainder of his time under him in the Gateshead Shops of that Railway. While so engaged he attended classes at the Durham College of Science under Dr. Garnett, and qualified as a Whitworth Exhibitioner. For two years or so after his time was up, he acted as inspector concerned with the testing of materials for the North-Eastern Railway, but in 1891 he resigned that appointment to take charge of a large copper smelting works in Wales. In the next year he joined the staff of the Chester Hydraulic Engineering Company, and was occupied in the design of Pelton wheels and hydraulic gear. Then, as an entire change, he was for some time in 1894 with the Elliott Metal Company, of Birmingham, and, still later, was made Engineering Manager at the Saltley Works of the Patent Axlebox and Foundry Company, Ltd.

Three years later—that is to say, in 1897—he joined in partnership with an old schoolfellow, Mr. G. H. Sheffield, who had, shortly before that time, started in practice as consulting and inspecting engineer at Newcastle-upon-Tyne. The partnership, under the style of Sheffield and Twinberrow, continued until 1905, and, during that period, he was, with his partner, interested in and jointly responsible for the designing of power station structures, the laying out of works, the equipment of self-acting railways, the design of steel works for public buildings and of steam engines. The partners were also concerned with the design of all-steel, high-capacity wagons, and, in 1901, actually built 30-ton self-discharging and other wagons for demonstration purposes.

The year 1905 saw the return of Mr. Twinberrow to the scene of his first appointment, for he was made head of the drawing-office in the Carriage and Wagon Department of the then North-Eastern Railway. He occupied that position for five years, and during that time was responsible for the design of the Company's passenger and wagon rolling stock. The next two years or so were occupied in travelling in Canada and the United States, and in Europe, and, thereafter, he was for a short time with the Brush Electrical Engineering Company, Ltd., at Loughborough. In 1913 he joined the staff of Messrs. Merz and Maclellan, consulting engineers, whose chief office was, at that time, at Newcastle-upon-Tyne, and who, subsequently, removed to London. He remained in the service of that firm for some seventeen years, and during that time was largely employed upon the mechanical section of designs and schemes dealing with electric locomotives and electric rolling stock.

In the beginning of 1931 he started practising on his own account in Westminster as a consulting engineer, specialising in electric locomotives and rolling stock. He also took especial interest in the development of the oil electric locomotive, in the future of which he had great belief.

Mr. Twinberrow was an Associate Member of the Institution of Civil Engineers, a Member of the Institution of Mechanical Engineers, and a Member of the Institution of Locomotive Engineers. As recently as January 29th he read a paper on "The Mechanism of Electric Locomotives" before the Institution of Mechanical Engineers in London. He was a man of exceptionally wide interest, something of a classical scholar, the master of four modern languages, and a student of literature.

Fiscal Policy and the Engineering Outlook.

THE departure of Great Britain from the gold standard necessarily aggravated the already serious state of instability which was the main characteristic of world trading conditions throughout 1931. During the last three months events have followed one another with such rapidity that any attempt to analyse future prospects for the engineering industries would have been merely to court disaster by fallacious prophecies. With the passing of the first month of the New Year, the task of undertaking such a survey becomes somewhat more feasible, because the essential basic figures relative to production in 1931 are now available for study in summary form, and the country has slowly re-oriented its standpoint to the altered circumstances.

The recent change in the country's fiscal policy inevitably requires the making of some forecast without which the framing of policy becomes inordinately difficult, and each basic industry at this time should be occupied in taking an inventory of its possible prospects so that the faults of the past may be rectified wherever possible, and avoided in the plans which are in preparation to deal with an entirely new set of conditions, with which each industry finds itself face to face in these times, at once so exceptional and so utterly out of joint as regards even the immediate past. Expert opinion varies widely with regard to the future prosperity of this country. There are pessimists who believe that its commercial predominance is past. A study of existing conditions in America and Germany, probably our greatest industrial competitors, might be likely to shake their fixed impressions quite considerably. There are optimists who believe that the departure from the gold standard can be turned to such good account that the productive capacity of this country will be required to the maximum, within a comparatively short span of years. The reality is likely to be not far from the median of these two extremes. The point stands out clearly from the experience of recent years, namely, that production is dependent in the long run upon prudent financial policy.

The engineering industry is so complex in its organisation, its interests, and its ramifications into every branch of trade that any forecast of its future prospects is particularly difficult, since benefit to one of the sections may seriously curtail the profitability of other sections. This complex situation has shown itself most clearly in the hesitation of the present Government to decide upon a tariff policy covering imported manufactures of iron and steel. Yet the more involved the position, the more essential is it to outline, in so far as the fog of trade depression and unstable foreign exchanges permit, the prospects as they appear to exist on the morrow of a change in British fiscal policy.

The changes in governmental policies, especially in Continental Europe, are so kaleidoscopic under existing conditions that detailed prophecy would be valueless, but the availability of trade figures covering 1931 and 1930—two years of dire economic distress—provide a measuring stick for a period which is hardly likely to prove considerably worse. The effect of a tariff on iron and steel manufactures will be widespread, and its probable incidence may be analysed, first, from the general standpoint, and, secondly, from the particular. Ignoring for the moment the question of counter-measures likely to be taken by foreign countries, it is incontrovertible that further restrictions on international trade, in any form, will reduce still further the demand for new shipping tonnage. Even since the first set of duties came into force there have been signs that shipping lines in the Continental trade intend to hold up orders for new construction, and they are selling their older vessels for scrap purposes. Such vessels have been run profitably in recent times only because of a heavy import trade, and such trade is now falling off considerably. A tariff policy will doubtless accentuate this trend, and still further increase the tonnage laid up in British ports, which at the end of December last totalled 728 ships of almost 2,000,000 tons. To this loss must be added the reduced demand for bunker coal, and the further export losses in trade due to additional restrictions on British coal exports. The lowering of the coal quota figure in France, prohibitive coal import freight rates in Poland and taxation of seaborne coal landed in Italy, may be quoted as examples of this tendency.

Shipbuilding output in Great Britain and Ireland fell to approximately 502,500 tons in 1931, or just over 30 per cent. of the world total, as compared with over 51 per cent. in 1930, but the drop in percentage is very largely accounted for by the fact that construction in the United States, Italy, and France is to a great extent made possible by State grants, either direct or indirectly through the shipping companies. Such policies are not likely to be operative over long periods of time, but for the moment figures of output should be regarded in that perspective. One cannot foretell how the counter-measures likely to be taken by foreign countries will tend to restrict the export of engineering products, but it is significant that even with the chaotic trade conditions existing in Europe, Continental countries took over 20 per cent. of our exported electrical machinery, about 35 per cent. of our exported machinery classed as prime movers not electrical, and a roughly similar proportion of our exported textile machinery. Preference, if granted to the importation of Imperial products, will doubtless react adversely on our export trade to Argentina and other South American countries, whither about 30 per cent. of our locomotive contracts were despatched last year. On the other hand, it is to be hoped that the adoption of Imperial preference may deflect a larger proportion of Dominion orders for locomotives, rolling stock, and various classes of machinery to works in this country. Published figures show that anywhere up to 30 per cent. of Indian and Dominion orders go to competitive European countries, but the number of such orders, at any rate as regards locomotives and rolling stock, is likely to diminish steadily as road competition in the Dominions grows, and the policy in such countries as South Africa and New Zealand is to build so far as is possible in the Administrations' own workshops. In Canada and the Australian States such a policy has been the practice for many years.

But the case for a change rests upon the natural desire to protect the home market. Home consumption of crude steel has ranged from about 8,500,000 tons in 1913 to around 9,600,000 tons in 1928, with a fall to about 6,000,000 tons in 1931. In the last quarter of 1931 imports of crude steel were roughly one-third of the home production, but this figure may be regarded as exceptional and increased by the fear of tariff restrictions. Exports of semi-finished iron and steel stood at rather over 100,000 tons, or about 50 per cent. of the comparable 1913 figure. For finished iron and steel exports for the last quarter of 1931 yielded a figure of nearly 375,000 tons, or just over 50 per cent. of the average quarterly figure for 1913. Neglecting any possible effect of tariff restrictions upon the internal price of crude steel, because increase of output to replace restricted imports should offset any attempt to profit by reduced competition, it would seem that the change in fiscal policy as regards iron and steel should provide an added potential demand of about 200,000 tons of crude steel, against which should be set the reduction in demand for shipbuilding, and a possible decrease in export trade. The tonnage in the latter cannot be accurately determined until something is known of the policies likely to be adopted by other countries, but at the present time export trade is so low that the effect is rather to be measured in terms of delay in export revival than in a reduction on present figures.

The inability of full protection of a home market to retain for a steel industry immunity from international trade depression is well exemplified by figures made public at the end of January by the United States Steel Corporation, which is reported to have sustained a net loss for the last quarter of 1931 of 4,376,788 dollars after providing for fixed charges and federal taxes. With United States steel production down to around 20 to 25 per cent. of capacity, the December output is little better than 50 per cent. of the average 1913 monthly figure; for Germany, in spite of a most efficiently equipped steel industry, the November, 1931, output was only equivalent to about 35 per cent., while the British figure has only fallen to about 70 per cent. Valuable as tariffs may be to protect a home market, the experience of the United States and Germany would seem to prove that they are not to be relied on to revitalise a productive capacity. Nevertheless, any increase of tariff restrictions must bring nearer the day when reciprocal trade agreements will be completed, freeing international commerce from this steadily creeping paralysis.

With wages and interest charges payable in a pound sterling lower than its parity gold value, the British engineering manufacturer starts with an advantage over most of his international competitors, and, fortunately, the bulk of his raw materials are not derived from countries at present on an effective gold standard. A further advantage accrues to him as a seller in that some of his best customers are also off the gold standard and therefore, naturally, turn to him as a cheaper source of supply. One point of considerable economic importance should not escape attention, as it has so often done in the past. It has been common practice to compare production statistics during the last decade with those of 1913, an accepted practice which has been adopted in this brief survey; statistically the choice of such a base cannot be protected, and 1924 or 1928 are likely in future to be regarded as more acceptable bases. British figures for 1926 and 1927 are vitiated owing to the industrial crisis of the earlier year. The war period stimulated engineering production in the newer countries owing

to the disorganisation of international trade routes, and post-war nationalism attempted to stabilise the new situation.

So far as can be judged, technical engineering skill, coupled with the high quality of British workmanship, should ensure this country a high position in competitive export markets as soon as confidence returns sufficiently to warrant progress on the many works now held in abeyance. But such improvement will necessarily be slow, since reserves have been used up to tide over the present difficult period, and capital can only be recreated if confidence prevails. With the increase of administrative and managerial efficiency more work is being accomplished with fewer productive units, which explains the heavy decrease in locomotives owned by railways in the United States, Germany, and Great Britain. Repair time has been cut by well over 50 per cent., mileage between overhauls increased by 100 per cent., and the turn round of ships so reduced that services can be operated with far fewer units. The world has learnt to live without large stocks in reserve, but it has found new products which it has come to regard as necessities, such as aeroplanes, and refinements to ensure the punctuality of service.

The future of British engineering activity would appear to depend largely on its ability to concentrate on the new products, and there is every evidence that it will emerge from the present depression as well, if not better, equipped than its competitors in this respect. It has suffered heavily during the last decade from competition of reparations in kind, and from the devaluation of its competitors' currencies. This period is rapidly ending, and the real danger from any change in fiscal policy lies in the possible removal of any spur to continued efficiency.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

BRITISH LOCOMOTIVE DESIGN.

SIR,—I have read with great interest Mr. Tuplin's informative article, "The Trend of British Locomotive Design," and although he is quite right in saying that all four of our railway groups now aim at building high-pressure early cut-off locomotives for main line work at least, I suggest that they are not all quite as successful as they might be in their results.

Mr. Tuplin states that it had long been recognised that early cut-off working was desirable, but that it was not until piston valves and long travel came into use that it became possible as a general thing to realise this ideal. I do not think that this is quite the position; many railways during the era of saturated steam and flat valves did run their locomotives as a general thing with quite short cut-offs. I know from first-hand experience that locomotives on the G.W.R. used to run on full regulator most of the time, the cut-off being brought back to as little as 15 per cent., and I feel pretty confident from information I have had that many such locomotives on other railways used to be worked in the same way; it would seem that it was only after the introduction of superheated steam and piston valves that the limited cut-off method of driving became general. Why these locomotives could run with such short cut-offs seems rather wonderful when one considers how early the compression must have been. Presumably the long passages necessary with the flat valve kept the clearance fairly large, and this with saturated steam that did not give a very steep compression curve kept the compression pressure down to a reasonable amount.

When superheated steam and piston valves came into use all railways with the exception of the G.W. kept to the old series of valve events and then the steeper compression curve of superheated steam and the generally smaller clearances of the piston valve made the compression pressure too high to allow of short cut-off working. Some railways employed piston valves that had just as long passages as flat valves, and I think it will be found that these could be run with appreciably shorter cut-offs than those with short, straight passages.

Mr. Tuplin gives credit to the G.W.R. for introducing piston valves, but surely the North-Eastern and Midland had introduced them at an earlier date for general use in express engines; what the G.W.R. did do was to thoroughly investigate valve gear operation and to establish that the lead must be kept small in relation to the lap if the compression was to be kept down with a line and line exhaust cavity, and this necessarily involved a large lap to give the necessary port opening. Of course, a large lap, whatever the lead, will improve the exhaust conditions. In spite of this, all other railways adhered to the small lap and large lead even when Walschaerts gear was used; in fact, this latter was usually given the same lead as was obtained with the old Stephenson gear in the notched-up position. One railway even introduced a long travel, but instead of using it to obtain a long lap actually wasted the travel in getting an extra late cut-off in full gear.

It was not until the exchange trials with the G.W.R. that the L.N.E.R. and the L.M.S. recognised the value of the former's method of valve setting and now have locomotives that can be successfully worked at short cut-offs. The S.R., however, while employing a large lap, still cling to a large lead, and in my humble opinion greatly handicap their locomotives by so doing. The "School" class of this railway are obviously intended to be short cut-off locomotives. They have a high boiler pressure and large cylinder volume, but they cannot be notched up earlier than 30 per cent. owing to compression knock; the "Lord Nelsons," I believe, can be run a bit shorter, but I understand they have the same trouble. Both these classes have obviously had great care and thought lavished on their design, and one wonders why the arrangement is persisted in. This same tendency is seen in the less important locomotives. The "L1" class are a modification of the "L" class of the old S.E. and C.R. with the valve gear re-designed to give longer lap and travel, but they cannot be run at any shorter cut-offs than those of the original design, and the reason again seems to be the insistence on a large lead; in the published particulars the lead is not given, but from the data available it would appear that the full-gear lead is about $^{5}/_{32}$in., and as the longer travel is got by using geared-up rocking shafts, the notched-up lead must be at least $\frac{1}{16}$in., which would give an excessive compression with the 1$\frac{3}{16}$in. lap.

The "King Arthurs" have the same valve setting as the "Schools" and "Lord Nelsons," and undoubtedly run at short cut-offs, and presumably it is the success of these machines that has led to the same valve events being employed on the latter locomotives; but whereas the "King Arthurs" have very heavy moving parts, the others are very lightly built and have not the same inertia forces to absorb the large compression pressure on the pistons. If only the S.R. would cut down the lead by half! It could be so simply done on the "Schools" and "Lord Nelsons," where a slight shortening of the full-gear cut-off would not greatly matter, just $\frac{1}{8}$in. added to each of the steam laps.

C. M. KEILLER.

Bexhill-on-Sea, February 8th.

PROFIT-SHARING IN INDUSTRY.

SIR,—I am greatly interested in Mr. Warren's letter as for twenty years I was Secretary of the Industrial Co-partnership Association, whose sole purpose is to aid in securing better relations between employers and employees by means of profit-sharing and co-partnership. Although the Association is mainly concerned with the introduction of schemes into single businesses and not into a whole trade, yet, naturally, it gave the keenest attention to the attempt to organise the wages of a trade on a profit-sharing basis. It is impossible to tell whether the scheme would not have succeeded under normal circumstances, but the circumstances were entirely abnormal; for it was started at the very moment when there was a catastrophic fall in prices, and coal mining fell from making high profits to its present state of struggling for existence. My own opinion, as a student of the matter, is that, had it been introduced ten or fifteen years earlier, it would have been successful and would have brought about relations between owners, managers, and workers which would have aided considerably, even fundamentally, in the reorganisation of coal mining which is necessary to-day.

The ordinary method of profit-sharing in a single business was introduced into coal mining by Mr. Henry Briggs in 1865 and was successful to a quite extraordinary degree in bringing about an entire change for the better in the relations between Mr. Briggs and his workers. The plan was cancelled after ten years because of misunderstanding on both sides, but its history proves—so it seems to me—that in the normal ups and downs of trade profit-sharing and co-partnership can be introduced into a coal mining business with every prospect of success.

Co-partnership is an extension of profit-sharing, giving to the employees, not only a share of the prosperity, but also a share of ownership—capital—and it may be a share in "control." By this last word is denoted a recognition that workers have minds and that they should have an intellectual connection with the business, first as to internal management and later as to directional control. Almost every kind of intermediate experiment is being made to-day in this matter, some of which are in engineering.

In the Brush Electrical Engineering Company, Ltd., after the shareholders have received a good rate of interest, 10 per cent., the workers receive most of the remaining profit and can have it in cash or capital. As a result most of the workers own shares in the business. In view of Mr. Warren's suggestion, that profit-sharing broke down when losses were being made, it is worth while noticing that the chairman of this company, Lord Vaux, in a recent letter to *The Times*, referring to the absence of any divisible profit, wrote: "It is often said as a criticism of co-partnership that it works very well in prosperous times, but fails in times of depression when employees receive no tangible result. We are in a position definitely to refute this statement, as we are appreciating more and more the spirit engendered by our scheme." Statements to the same effect have been made repeatedly by Mr. T. C. Taylor, the head of the well-known co-partnership business, J. T. and J. Taylor, Ltd., and by Dr. Charles Carpenter, president of the South Metropolitan Gas Company, which, in 1889, was the first gas company to adopt co-partnership. Now there are fifty-nine gas companies sharing profits with their 44,000 employees who own £3,148,000 of capital. In various branches of the iron and engineering trades there are a number of successful experiments in profit-sharing and co-partnership, as, for example, Hans Renold, Ltd., chain makers, at Didsbury; Taylor, Taylor and Hobson, Ltd., instrument makers, at Leicester; and the Ocean Ironworks at Manchester. Benham and Sons, Ltd., hot water engineers, in London, give one-tenth of their profits to the staff and one-tenth to the other workers. Mr. Stanley Benham has spoken highly of the effects, both as to good relations and also on the success of the business. Some recent co-partnership plans have laid great emphasis on bringing the workers into close connection with the management and direction. Examples of this in engineering are found in the schemes of R. A. Lister, Ltd., of Dursley; John Thompson, Ltd., boilermakers, of Wolverhampton; and Thompson Bros., Ltd., of Bilston.

These last experiments are probably pointing the way for future progress: that when the workers share in profits and ownership ways will be sought and found to give them much greater opportunity to know and understand the organisation and management of the business and to secure their intellectual contribution towards its operation and success.

E. W. MUNDY,
Member of Executive of the Industrial Co-partnership Association.

48, Temple Fortune Hill, N.W. 11,
February 15th.

SIR,—The recent correspondence on this subject is certainly interesting to those who have either advocated or tried this method of getting, on the one hand, a higher output per man, and, on the other hand, of letting the producer get a better return. Mr. N. P. Gilman is reported to have stated that the employee *creates* a fund, but surely this is hardly correct. We recall many years ago, just after the slump in 1920, things were by no means on a sound basis, and we found that the profit-earning basis could only be reached by increasing output per man-hour at least 20 per cent. A figure was therefore agreed as a basis per 100 man-hours, and any percentage above that was the percentage of bonus paid each month on the wages of that month, producers getting it in full, those only accessory, such as stores and order departments, getting only 50 per cent., as whilst they could help output by seeing that materials were ordered in time and so on, they did not produce.

Taking 1931, the bonus paid to twenty-seven employees was over 20 per cent. on the regular wage, and now that we are working overtime since the devaluation of the pound, the percentage has increased to nearly 30 per cent. As we turn out a variety of small tools, we have had to scale them out into a calculated production, based on a comparison with the article produced in largest quantities. This happens to be hand hack saw blades, and a machine saw longer than 14in. is reckoned as three of the hand blades and so on. If there is any slacking anywhere, the management has no trouble, for the workers do the urging—and swearing—and, of course, if any work is spoilt that is deducted, and as the new replacement comes in the total, they get penalised if careless. In this way, we think we can claim that our employees are as keen for good high-class work to be done as the management themselves. Our scheme is something like the Priestman, but altered to suit our articles and conditions.

FRY'S (LONDON), Ltd.,
A. P. SCHOVE, Managing Director.

Greenwich, S.E. 10, February 12th.

PROTECTION AND PROGRESS.

SIR,—May I make a few comments on your article entitled "Protection and Progress," in your issue of February 12th?

As an engineer unable to obtain work, and approaching middle-age myself, I believe I express the view of my fellow-sufferers in adversity in describing the outlook as depicted by you to be gloomy in the extreme.

Surely those who are directing our destinies at Westminster and elsewhere have something more hopeful in view than a permanent tariff war with no prospect whatever of returning to anything like pre-war prosperity. Or do they merely regard that state of affairs as a good thing in itself?

To my mind, the only excusable object of a tariff war can be a freer-trade peace and better trading relations between ourselves and our neighbours, just as we fought the Great War in defence of liberal principles, and concluded it with an effort to re-establish the world on a juster and more stable basis.

If some such objective as this is not attained, and we are to embark on a prolonged tariff struggle with the inevitable suffering and embitterment attendant on any kind of warfare—even assuming we are able to improve our relative position, at someone else's expense, presumably—such a prospect as this would be little better than an acknowledgment of failure by our industrialists and capitalist system, and must inevitably result in the discrediting of that system the world over, and in its replacement by some other, probably Socialism or Communism.

The most cogent argument recently employed in persuading Free Traders to support a Protectionist policy was the hope that by that means the world would be induced to adopt a saner attitude on the whole question of tariffs, thoroughly bad in principle as they undoubtedly are.

CHARLES ROSCOE.

Westerham, Kent, February 12th.

FEBRUARY 15TH was the fiftieth anniversary of the founding of the frozen meat trade between New Zealand and England. In November of 1881 the Shaw, Savill and Albion sailing ship left Port Chalmers, New Zealand, with 2000 carcasses of mutton, which were frozen on board by the ship's refrigerating plant. The crank shaft of the compressor, however, broke and the cargo was off-loaded. When the repairs to the compressor had been completed, a new cargo of mutton was taken on board on February 15th, 1882, and was safely delivered in London on May 24th, 1882. The "Dunedin" made nine other successful voyages to New Zealand, but was finally lost with all hands off Cape Horn.

The Mechanism of Electric Locomotives.*

By J. D. TWINBERROW, M. I.Mech. E.

(*Concluded from page* 184.)

Running Gear.—The wheel base of the $\frac{E\,A}{1}$ class is differentiated from the "Pacific" type in that the pony axle is united with the next driving axle to form a four-wheel truck of 9ft. wheel base. Fig. 19 indicates that the inner end of the truck is formed as a steel casting embracing the driving axle-boxes and carrying a pivot pin which is anchored to a cross bar on the main frame immediately behind the casing of the driving gear. When on curves the truck radiates about the pivot pin with a consequent radial displacement of the driving axle with respect to the fixed trunnion bearings of the universal connections. The buckle of the bearing spring is seated spherically in a stirrup hung from each axle-box—Fig. 16. The seating is linked to the adjacent end of the equaliser, and is spigoted to the base of the stirrup, which is thus free to swing with the axle-box without affecting the position of the spring. The outer end of the truck is supported by laminated springs from the pony axle, the lateral movement being controlled by laminated springs acting horizontally. The load is supported on a pair of blocks mounted on V-shaped slides in order to increase the effect of the friction in damping out sway oscillations. A vertical pillar standing on each slide block receives the load from a laminated spring, of which the buckle is attached to the extremity of a cross bar, passing transversely through the engine frames. These laminated springs are each connected by equalising levers to the three sets of driving springs at their respective sides. The bearing springs of the four-wheel bogie truck are independent, the load being equalised thereon by the pivoted centre bearing. Adjustable spherically seated rigid side bearings are applied, so that there is no transverse equalisation at either end of the locomotive, and both groups of bearing springs are thus effective in controlling oscillation about a longitudinal axis. In this locomotive the stiffness of each driving spring with its pair of volute auxiliary springs is 56 tons per foot, that of the laminated spring and helical auxiliaries as fitted to the bogie truck is 28·5 tons per foot, but only 18 tons per foot in the case of the pony axle having two laminated springs in series, in addition to helical auxiliaries. Under equal angles of roll the percentage of variation in the load would be less on the pony than on the driving axles, but for the fact that the equalising connection maintains due proportionality by modifying the trim of the superstructure.

The four-wheel bogie—Fig. 20—having a wheel base of 8ft., is of the type which was originally fitted to the Brown, Boveri high-speed locomotives for the Paris–Orleans Railway. A similar type of truck but with 9ft. wheel base is fitted at each end of locomotive "No. 4002." The special feature of this truck consists in the application of lateral control springs fore and aft of the centre pivot which tend to compress pairs of levers, the outer ends of which are anchored to the main cross member of the truck, whilst their inner ends are fitted with rollers which react on the equaliser block of the centre pivot. The levers are also fitted with abutments, near the rollers, which come in contact with stops on the main cross stay, so that the levers cannot follow up the movement of the centre pivot block when it recedes from them, though they oppose its approach and thus exert a righting effort for both lateral and angular displacements of the truck with respect to the block.

The equalising block is mounted on a massive transverse pin attached to the superstructure. The block carries a hemispherical pivot at each end, the sockets for which are machined to slide on V-shaped grooves which damp out synchronous oscillations by reason of the friction.

The bogie frame is effectively braced by a single central casting which is connected by flanged stretcher plates to the headstock at each end. Brake blocks are applied to the inner face of each wheel.

The outside bearing springs of the driving axles for locomotive "No. 4001" are mounted on sliding seats supported on the tops of the axle-boxes. The axle-boxes are interchangeable, but the hornblocks for the middle axle are fitted with liners on the face only, not on the edges, whereas the spring seat is grooved to fit the blocks. The middle axle-boxes may therefore be displaced transversely in either direction to ease the passage of curves. Sliding spring seats require the provision of long journals when a large amount of lateral travel is required. When the play in either direction reaches one-sixth of the effective length of the journal the intensity of the bearing pressure is increased by 100 per cent. at one end and reduced to zero at the other. Truck frames mounted on the journals are preferable to boxes fitted independently to each end of a pony axle. The four-wheel bogie truck at each end is independently equalised by means of beams spanning the axle-boxes and supporting an inverted laminated spring at each side. The frames are stabilised by means of the large flat pivot bearing with a cross slide of "Adams" type. As there are three compensated spring groups at each side the reactions to torque and to braking effort are provided by transference of load from one bogie truck to the other without modifying the adhesion, but three groups are not so freely adaptable as two groups to vertical irregularities of the track. The use of more than two groups necessitates the provision of means for adjusting the due distribution of the weight upon the axles. The springs of the driving axles are spaced 7·75ft. transversely and those of the carrying axles 4·3ft. The load per journal on the carrying axles is 0·65 of that on the driving axles. The ratio of the stiffness of the bogie to the driving springs, from the point of view of controlling the rolling motion, should be :—

$$\frac{0{\cdot}65\times 7{\cdot}75^2}{4{\cdot}3^2}=\frac{2{\cdot}1}{1}$$

The actual stiffness is 34·5 tons per foot for the bogie springs referred to each journal and 36 tons per foot for each driving spring with its auxiliaries. Advantage would result from decreasing the stiffness of the driving springs, but this would involve increasing the stroke to be accommodated by the movement of the universal driving connection.

The inscription of the wheel bases of the passenger engines in a curve, with $\frac{1}{4}$in. play between the flanges and the rail at each side, is given in Fig. 21.

Articulating Joints.—The articulating joint which connects the two motor bogie trucks of each South African locomotive is indicated in Figs. 7 and 8. The joint hinges freely on vertical and horizontal axes. Each part is secured by means of a horizontal pin in a casting of box form, built into the end girder of the frame.

The greater length of the freight engines for the 5ft. 6in. gauge necessitated the adoption of the modified form of joint shown in Fig. 22. Diagonally opposite inner corners of the two trucks are connected by links to the shorter arms of a pair of bell cranks each pivoted on a vertical pin attached to the body framing. The longer arms of the bell cranks are connected by tubular links, the continuity of which is interrupted by the insertion of a cylinder containing two piston-like follower plates enclosing two volute springs in series under heavy initial compression. The cylinder is free to move through cylindrical guides. The whole assembly acts as a rigid connection between the bell cranks until the intensity of the push or pull in the rods exceeds the initial compression on the springs. The additional travel of the springs allows an extension or reduction of the normal length between centres of end pins, so that, in case of need, the bogie trucks may assume different angular positions with respect to the centre line of the body, without imposing excessive lateral pressure on the rails.

Experience with both of these types has demonstrated that the wear of tires is increased by about 50 per cent. when independent lateral play of the adjacent headstocks is permitted. The engines on the 3ft. 6in. gauge with nose-suspended motors average 91,000 miles between tire turnings. The six-wheel coupled engines on the 5ft. 6in. gauge promise an increase on this figure.

Brake Work.—There is difficulty in providing the space necessary to receive the cylinder, reservoir, way-shaft, &c., of the vacuum brake. The time required for the release is a source of delay, which is accentuated when working at high altitudes. The influence of the barometric pressures of 30in., 27½in., and 25in. of mercury on the time is plotted in Fig. 23 for ruling vacua of both 15in. and 20in.

The control of heavy trains on inclines and the arrest without shock renders it desirable to control the engine brakes independently of those on the train, but in normal working the application and release of the engine brakes should be strictly in unison on both train and engines. This requirement is effected by the "proportional valve," a section of which, as developed by the Westinghouse Brake Company, is given in Fig. 24. The diaphragm 1 at the right of the figure separates the compartment 2, in which constant vacuum is maintained, from the chamber 3, which is in communication with the train pipe. Admission of air to the train pipe causes the diaphragm to move to the right, rocking the bell crank 4 and lifting the piston 5 and the air admission valve 6. The relation between the effective area of the diaphragm and that of the piston is such that the piston descends and closes the admission valve when the air pressure in the brake cylinders corresponds to the degree of destruction of the vacuum in the train pipe. When the vacuum is restored the piston descends until it opens the release valve 7, the pressure falling in due proportion to the degree of restoration of vacuum.

A diagrammatic lay-out of the air and vacuum apparatus on the Indian freight locomotives is given in Fig. 26.

When descending gradients under regenerative control the retardation required is adjusted electrically to suit the required speed under the acceleration due to the action

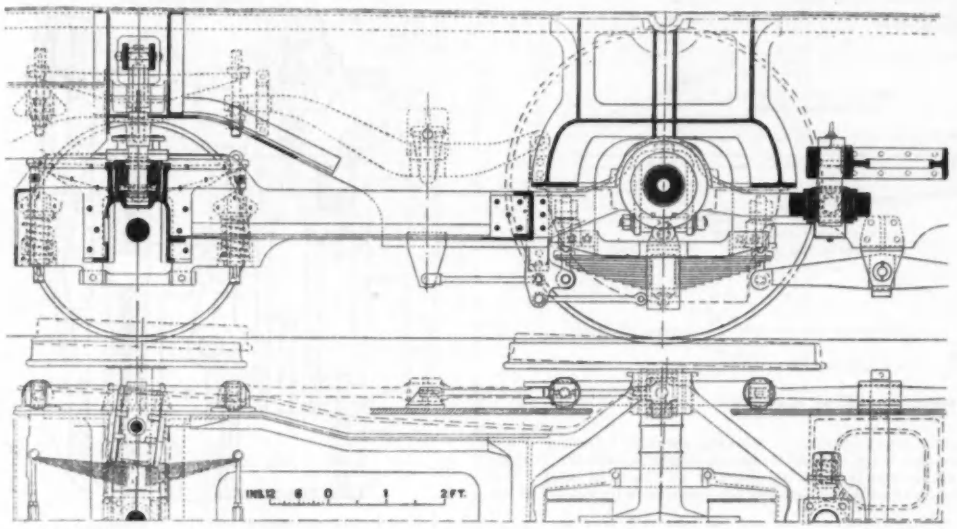


FIG. 19—JAVA BOGIE TRUCK

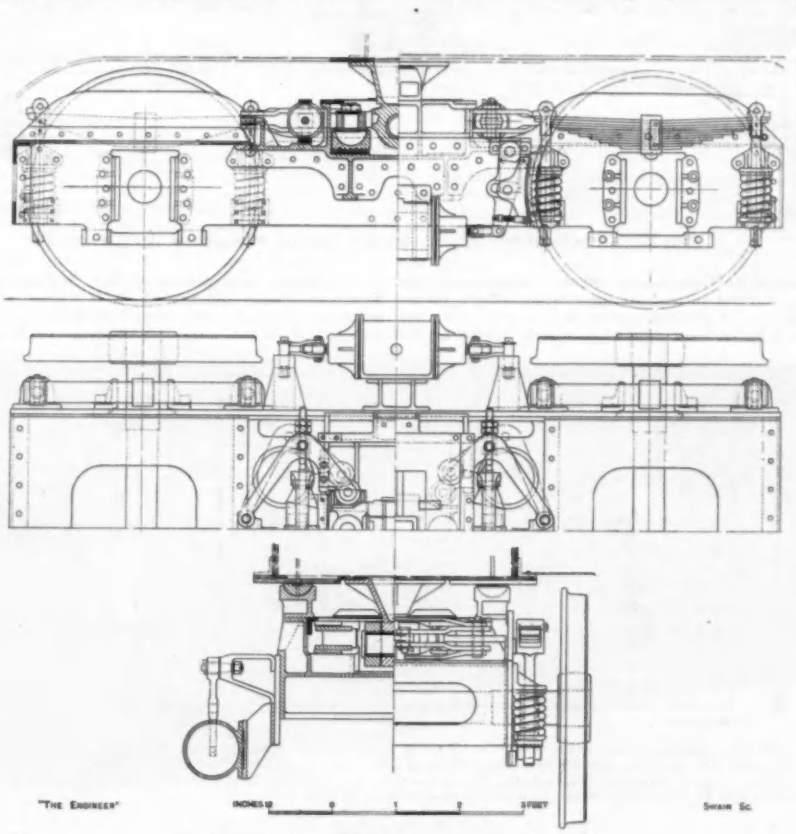


FIG. 20—FOUR-WHEELED BOGIE TRUCK

* The Institution of Mechanical Engineers, Jan. 29th, 1932.

of gravity as modified by the resistance due to curvature. The engine brakes are cut out by the closing of the regenerative circuit, the train brakes being applied or released independently as required. An emergency brake application automatically opens the regenerative circuit and connects the engine brakes to the proportional valve.

Clasp brakes are fitted to the wheels of individually driven axles, as the boxes and hornblocks are not necessarily designed to take heavy unbalanced thrust. One block only is fitted to each of the coupled wheels of the freight engines. A parallel motion device is fitted to the head of each brake lever applied to wheels having lateral play in the frames, in order that the blocks may play transversely without binding. Each block comprises a steel head and a renewable cast iron shoe, with expanded steel insert, to prevent the falling away of cracked portions. The shoes will attain a red heat if heavy trains having brakes in bad order are controlled on the gradients mainly by the engine brakes, in the event of regenerative working being temporarily suspended. Each block is kept floating on its pivot pin by means of a slotted drag link attached to its lower extremity, working through a friction clamp on the lever. This is essential if consistently uniform retardation is to be obtained at all stages of wear. It is also advisable to provide for uniform adjustment of the slack, without expenditure of time in the running shed. The hand brake spindle, which is shown in Fig. 25, is arranged with automatic control of the slacking off, so that an application and release of the hand brake maintains a constant amount of slack in the brake rigging. It will be noted that rotation of the spindle to apply the brake causes the adjusting screw, with left-hand thread, to rise whilst the slack in the brake rigging is being taken up. If a sufficient amount of wear has taken place the adjusting screw will lift the pawl carrier box at its lower end, causing the pawl to travel over one or more of the teeth of the adjacent rack bar. On releasing the brake the handle can be rotated in the left-hand direction only by the amount necessary to restore the end of the adjusting screw to the bottom of the carrier box.

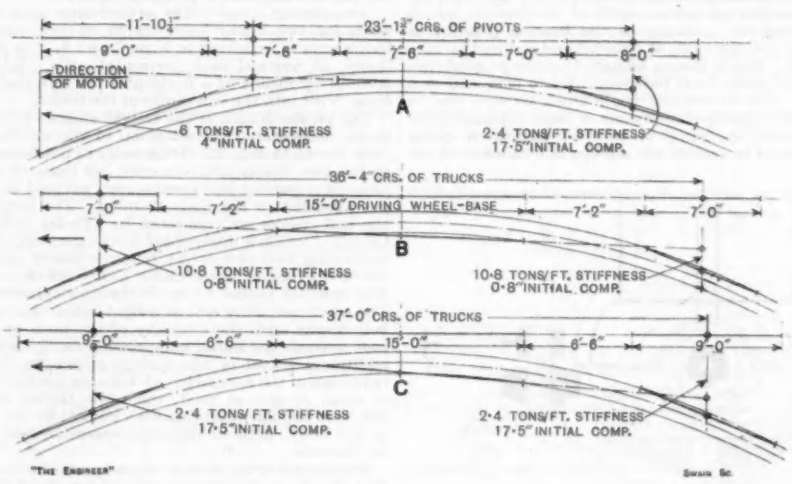
It must be noted that if the hand brake is applied when the air brake is on, it will not continue to hold when the air brake is released. When locomotives are left unattended with the brakes applied, the air brakes must be fully released and the hand brakes screwed on.

Another form of slack adjuster was fitted to each type of express locomotive, of which the mechanical parts were made by Messrs. Hawthorn, Leslie. From Fig. 27 this will be seen to consist of an epicyclic gear driven from a bevel wheel on the vertical spindle of the hand brake in mesh with a wheel on the planetary arm. This wheel is rigidly connected to a bevel wheel of different diameter which engages with teeth formed on the rim of the bracket casting. The end of the planetary arm when rotated in the direction of brake application meets a stop on the upper casing of the bracket and this casing carries a spring-loaded pawl, which drops over the teeth of a crown ratchet on the main bracket.

When the brake is released the planetary arm recedes from the stop and after travelling through a nearly complete circle is arrested on the opposite face of the stop, further rotation being prevented by the engagement of the pawl and ratchet, the full release being accomplished by about five and a-half turns of the handle.

Brake blocks are fitted to all bogie wheels. The reaction to a heavy brake application brings additional weight to bear on the leading groups of wheels, whilst retarded rotation also tends to prevent the flanges from climbing the rails.

Design and Manufacture.—The locomotives, to which



A. Passenger locomotive $\frac{E\,A}{I}$ (Metropolitan-Vickers). B. Passenger locomotive $\frac{E\,B}{I}$ (General Electric).

C. Passenger locomotive $\frac{E\,C}{I}$ (Brown, Boveri).

FIG. 21—INSCRIPTION OF WHEEL-BASES IN CURVES

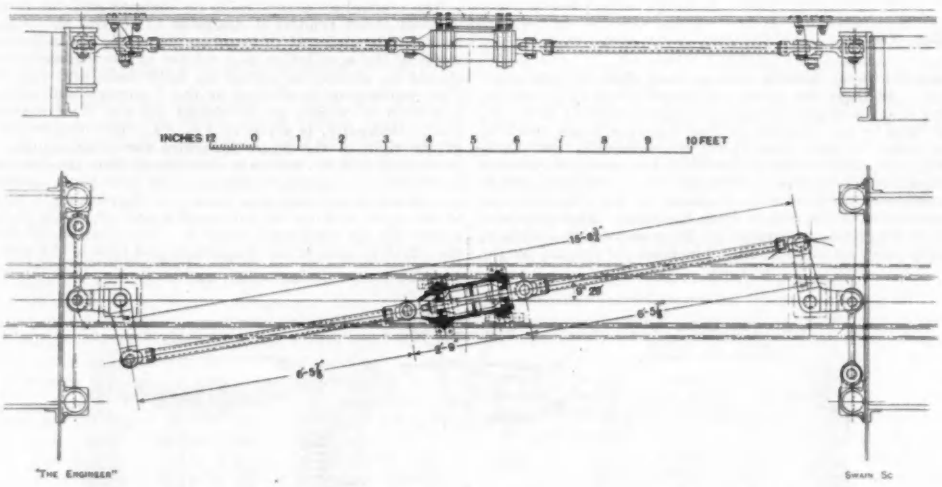
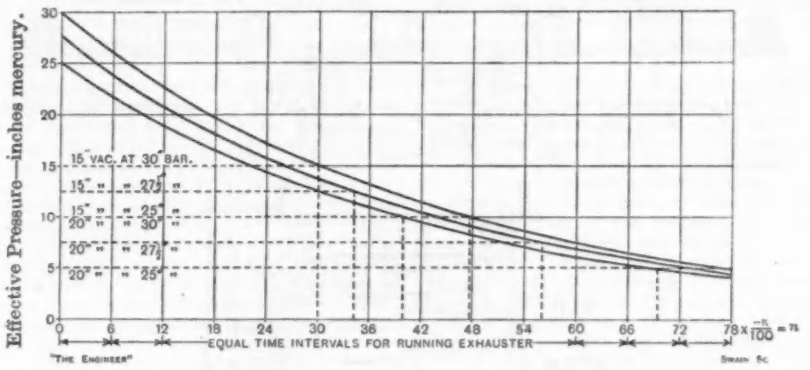


FIG. 22—ARTICULATING JOINT—GREAT INDIAN PENINSULA RAILWAY



NOTE.—Suppose that a brake system of Q cubic feet capacity is to be exhausted by a pump which increases the reservoir capacity by a small fraction $d\,Q$ in the limited time occupied by, say, one reciprocation. Under constant temperature, the pressure in the reservoir falls from the atmospheric P_a to a new value P_1, whilst the volume increases from Q to $Q+d\,Q$, then

$$P_1 = P_a \frac{Q}{Q+d\,Q}$$

so at the end of any number of cycles n,

$$P_n = P_a \frac{Q^n}{(Q+d\,Q)^n} \qquad \therefore \log \frac{P_n}{P_a} = n \log \frac{Q}{Q+d\,Q} \qquad \text{and } n = \frac{\log \frac{P_n}{P_a}}{\log \frac{Q}{Q+d\,Q}}$$

$$\text{which} = \frac{1}{\log \frac{Q}{Q+d\,Q}} (\log P_n - \log P_a) = K (\log P_n - \log P_a) = -K (\log P_a - \log P_n)$$

FIG. 23—VARIATION OF TIME OF RELEASE OF VACUUM BRAKE

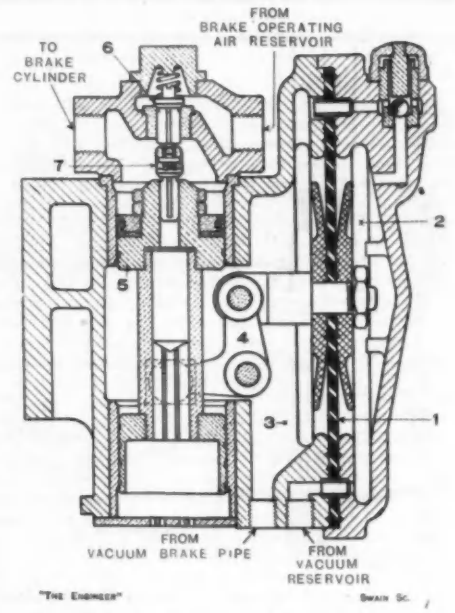


FIG. 24—PROPORTIONAL BRAKE VALVE

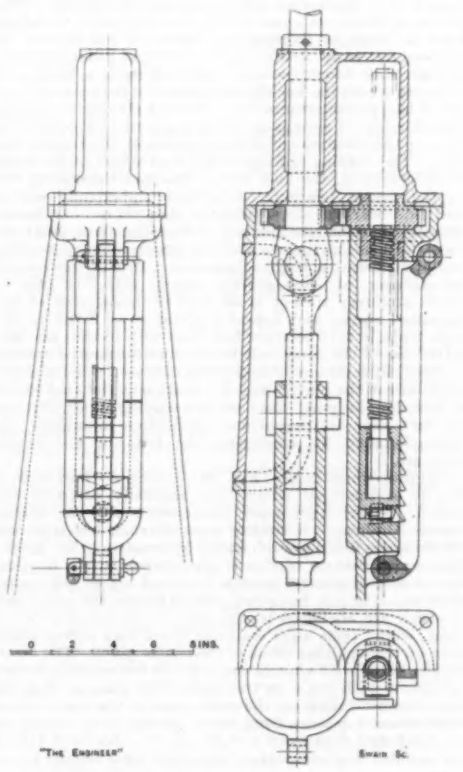


FIG. 25—HAND BRAKE AND AUTOMATIC SLACK ADJUSTER

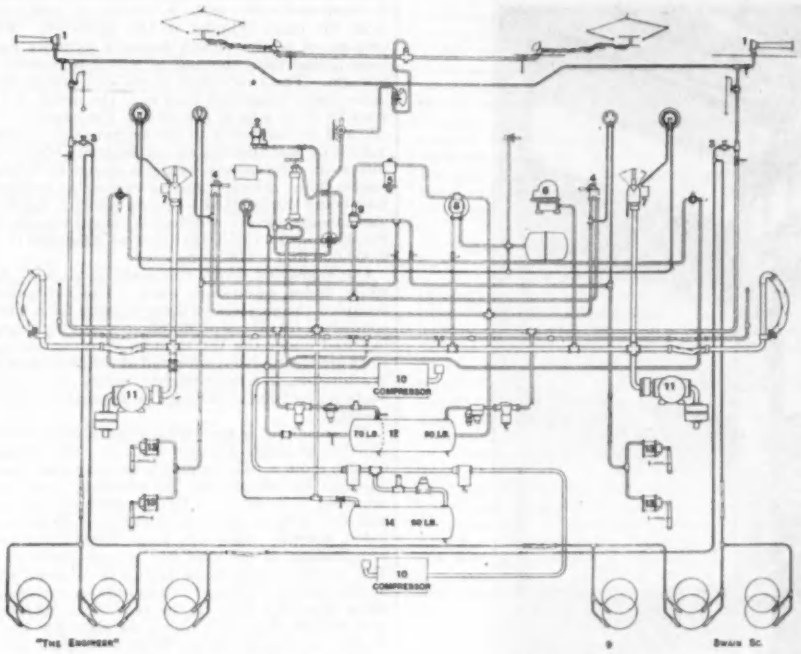
detailed reference is made, were produced to the specifications of Messrs. Merz and Partners, by the following contractors :—

The Metropolitan-Vickers Electrical Export Company.—Locomotives of 3ft. 6in. gauge for the South African Railways, with the Swiss Locomotive and Machine Works and Messrs. Robert Stephenson and Co. as sub-contractors for the mechanical parts. Freight locomotives of 5ft. 6in. gauge for the Great Indian Peninsula Railway with the Swiss Locomotive and Machine Works and the Vulcan Foundry Company as sub-contractors for the mechanical parts. Passenger locomotives of 5ft. 6in. gauge for the Great Indian Peninsula Railway with the Swiss Locomotive and Machine Works as sub-contractors for the mechanical parts.

The General Electric Company.—Passenger locomotives of 5ft. 6in. gauge for the Great Indian Peninsula Railway.

The British Brown-Boveri Company.—Passenger locomotive of 5ft. 6in. gauge for the Great Indian Peninsula Railway. Messrs. R. and W. Hawthorn, Leslie and Co. were the sub-contractors for the mechanical parts of the last two examples.

The author desires to acknowledge the above sources of his information, and to express his thanks to the consulting engineers and to the contractors.



1. Typhon horns.
2. Compressor controller.
3. Sander valves.
4. Straight air brake valves.
5. Brake cylinder cut-out.
6. Brake cut-out and regenerative governor.
7. Vacuum brake valves.
8. Proportional valve.
9. Double check valve.
10. Air compressors.
11. Vacuum exhausters.
12. Brake and control reservoirs.
13. Air brake cylinders
14. Main reservoir.

FIG. 26—LAY-OUT OF AIR AND VACUUM APPARATUS

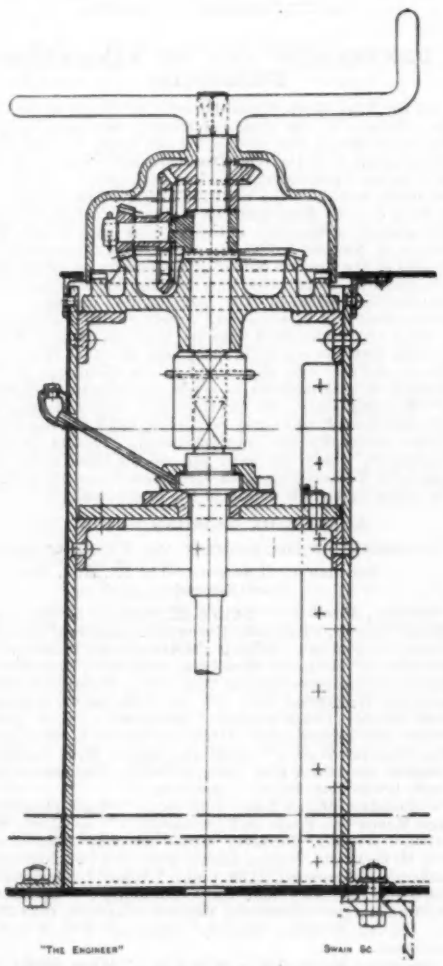
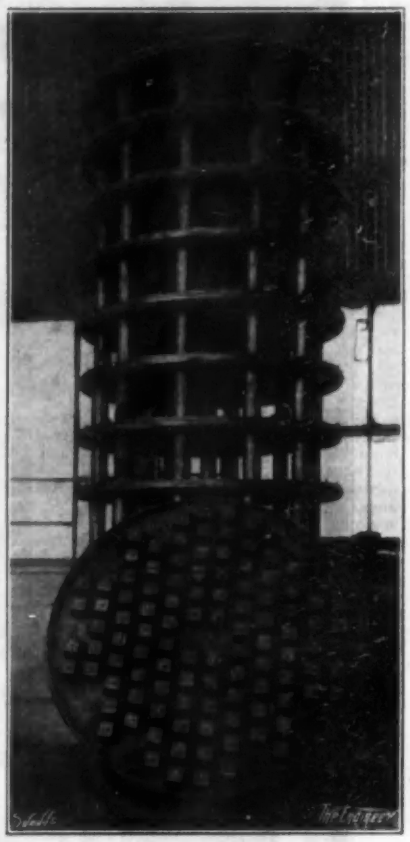


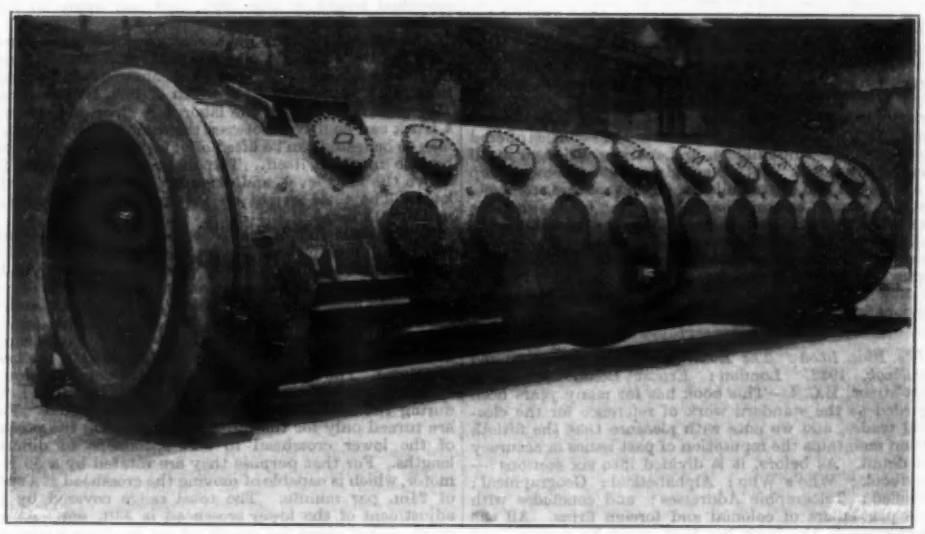
FIG. 27—HAND BRAKE AND AUTOMATIC SLACK ADJUSTER

Electrically Welded Fractionating Columns.

THE photographs reproduced on this page illustrate an interesting piece of work recently carried out by Thompson Brothers (Bilston), Ltd., of Bilston, Staffordshire, to the order of Shell-Mex, Ltd. The fractionating column shown is one of a number of such columns, and is claimed by Thompson Brothers to be the first of all-welded construction to be used in this country. Each column consists of a domed top, two cylindrical section shells and a bottom expansion piece, the latter, of course, being connected to the still. The plant when erected is supported on girders by means of four feet, two of which are to be seen in the engraving. Inside each of the columns there are twenty-two trays, and access is obtained to each tray by means of a manhole. The top cover is dished and flanged from $\frac{1}{4}$in. mild steel plate, and fitted with connecting ring baffle plate and reflux pipe. The body shell, which is made in two parts, is 7ft. 2in. in internal diameter, the plate being $\frac{3}{8}$in. thick. The manholes are of some interest. They were pressed in one piece, with a machined flange $\frac{1}{2}$in. thick. The trays fitted inside the column are 7ft. 1in. in diameter, pressed with a flange $3\frac{1}{2}$in. deep and made of $\frac{3}{16}$in. plate. The bottom tray is supported on a grid constructed of 6in. by 1in. flats, the remaining trays being erected one upon the other, and supported by $5\frac{1}{2}$in. diameter steel pipes welded in. These pipes form the weirs for each tray. Pressed steel square bubble caps are fitted to each tray, there being 104 caps per tray, equivalent to 2288 per column. Provision is made in each tray for a packing gland and ring, the packing being fine asbestos material. All joints were made by means of copper-asbestos gaskets. Each completed column weighs about 26 tons.



TRAY ASSEMBLAGE



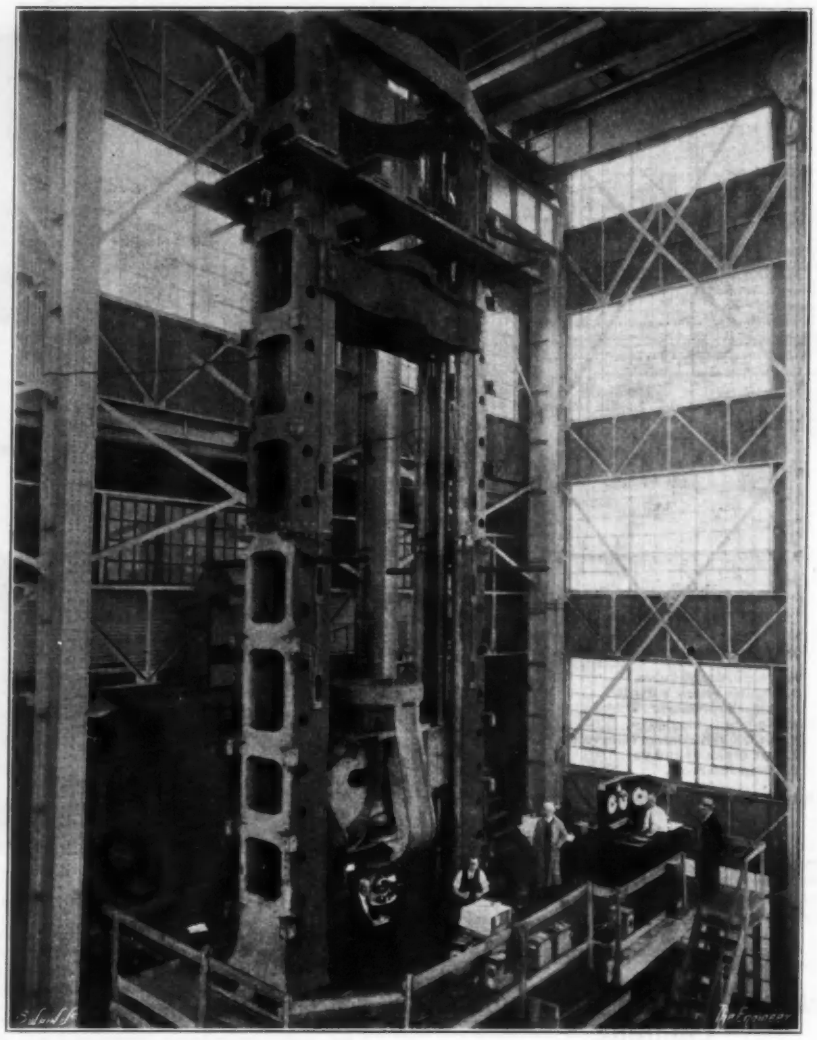
WELDED FRACTIONATING COLUMN

BOOKS OF REFERENCE

Specification : for Architects, Surveyors, Civil Engineers, and for all Interested in Building. Edited by F. Chatterton, F.R.I.B.A. London : The Architectural Press, 9, Queen Anne's-gate, S.W. 1. Price 10s. 6d. net.—This reference volume has had for many years a definite place of value in the offices of all connected with the architectural and building trades, and the thirty-fourth edition is well in keeping with the standard set by previous issues. One pleasing improvement is the new form of binding, giving it a dignified appearnce, which hitherto it somewhat lacked. There are two new features, which, the publishers state, are to be made permanent, the first being an illustrated description of "The Building of the Year," that awarded the current R.I.B.A. London Architecture Medal and Diploma—this year the Westminster Bank, Threadneedle-street. The second feature is a new section entitled "The Acoustical Engineer," dealing comprehensively with acoustical problems and giving the latest available

1785-TON TESTING MACHINE

BALDWIN-SOUTHWARK CORPORATION, PHILADELPHIA, ENGINEERS



information thereon. The five special articles this year are :—"Modern Store Design," "Architectural Leadwork," "Indirect Artificial Lighting," "Some Flooring Surfaces in General Use," and "The Equipment of the Domestic Kitchen." Admirable coloured plates of bricks, tiles, and stones deserve special mention. We have for several years pointed out the value of this volume to the professions it caters for, and have no hesitation in saying that with the constant improvements and changes taking place in architectural and building practice it will be found indispensable to all progressive firms and individuals.

Directory of Shipowners, Shipbuilders, and Marine Engineers. Compiled under the direction of the Editor of the *Shipbuilding and Shipping Record.* London: The Directory Publishing Co., Ltd., 33, Tothill-street, S.W. 1. Price 20s. net.—The new edition has been completely revised and now gives more than 25,000 index references. It provides ready reference to the facilities offered by shipowners, shipbuilders, and marine engineers in all parts of the world. Details are given as to the ownership of all vessels and their builders, engine makers, tonnage, draught, year of commissioning, &c. The book also gives particulars as to the capacities of the various shipyards and the names of the directors and leading officials of all the shipowning and shipbuilding companies. This directory is very well known to all connected with the industry, and the new edition will prove itself as indispensible as the previous issues.

The Blue Book: The Electrical Trades Directory and Handbook, 1932. London: Ernest Benn, Ltd., 154, Fleet-street, E.C. 4.—This book has for many years been regarded as the standard work of reference for the electrical trades, and we note with pleasure that the fiftieth edition maintains the reputation of past issues in accuracy and detail. As before, it is divided into six sections :—Handbook; Who's Who; Alphabetical; Geographical; Classified; Telegraphic Addresses; and concludes with some particulars of colonial and foreign firms. All the information in the book has been carefully revised, and in some cases enlarged.

AT the end of 1930 a total of 24,463 miles of precise levels had been run in Canada, establishing 8544 bench marks. This enormous network, extending from the Atlantic to the Pacific coast, has been rigorously adjusted by mathematical methods, and the results published in a series of publications, giving the elevation and description of the bench marks, all of which are based on mean sea level datum.

A Very Large Testing Machine.

WHAT is claimed to be the largest testing machine in the world has recently been completed by the Baldwin-Southwark Corporation, of Eddystone, Philadelphia. This machine, illustrated herewith, has been built for the new laboratory of the University of California at Berkeley. It is designed to test in compression columns up to 33ft. 6in. long, and under loads up to about 1785 tons. In tension it will accommodate specimens having a stretched length of 33ft. 6in., and can apply to them loads up to about 1340 tons.

The machine stands on a cast steel table, measuring 17ft. 3in. by 6ft. 6in. in plan and 35in. in depth and weighing nearly 22 tons. The cast steel columns rising upwards from the table have a clear width of 10ft. between them. The table is level with the laboratory floor and therefore a truck can be driven between the columns, and the specimen to be tested can be lifted off it and set up into position by the machine itself. The machine stands 46ft. 9in. above the floor level, and extends about 25ft. below that level. The total weight on the foundations is approximately 212 tons.

To the underside of the table there is secured the main ram, 46in. in diameter. This ram is made of close-grained cast iron and weighs about 12½ tons. A cast steel cylinder, weighing nearly 18 tons, moves on the ram. It is provided with lugs, whereby it is coupled to a pair of vanadium steel screws, 12in. in diameter, 56ft. 8in. in length, and cut with a double square thread of 3in. pitch. These screws are embraced by long bronze nuts, embedded in the lower crosshead. The screws transmit the load from the hydraulic cylinder beneath the table to the lower crosshead, but during the loading process they are not rotated. They are turned only for the purpose of adjusting the position of the lower crosshead to suit specimens of different lengths. For that purpose they are rotated by a 50 H.P. motor, which is capable of moving the crosshead at a speed of 24in. per minute. The total range covered by the adjustment of the lower crosshead is 33ft. 6in. At any point of that range the crosshead can be given a straining stroke of anything up to 4ft. Compression specimens are tested between the lower crosshead and the table, and tension specimens between the upper and lower crossheads. The straining stroke of the lower crosshead is therefore always in the downward direction. The hydraulic power for the straining movement is obtained from a multiple rotating cylinder pump, driven by a 20 H.P. motor, and capable of delivering 15 gallons per minute. At full capacity, the hydraulic pressure is 2500 lb. per square inch. The return movement of the lower crosshead, after a test has been completed, is effected by means of two pull-back cylinders, each 13in. in diameter and supplied with pressure from the same source as the main cylinder. These pull-back cylinders in conjunction with four sets of heavy springs serve the additional purpose of absorbing the energy which is suddenly released when a specimen is fractured under test.

For the purpose of measuring the load on the specimen the pressure in the main cylinder is not measured. Instead a device known as the Emery support or hydraulic capsule, is interposed in the path by which the load is transmitted from the main cylinder to the specimen. This capsule consists of a very heavy inelastic cylinder containing a loose-fitting ram, the end of which is covered by a diaphragm. The movement of the ram within the cylinder under the transmitted load is of the order of a few thousandths of an inch at the most. The capsule is filled with oil, and is connected to elastic tubes in a series of four indicating instruments on an adjacent board. The pressure within the capsule causes a change in the shape of the elastic tubes, which change serves as an indication of the load being transmitted to the specimen. Each of the four instruments covers a different range, namely, from 0 to 200,000 lb., 0 to 525,000 lb., 0 to 2,000,000 lb., and 0 to 4,000,000 lb. (=1785 tons).

Our engraving shows the machine in the makers' works while under calibration tests. The calibrating process occupied the services of three experts for a week. It was conducted by means of Morehouse proving rings, as manufactured under the Whittemore-Petrenke patents. These rings are themselves calibrated at the Bureau of Standards, Washington, in a deadweight machine, by means of which loads up to 100,000 lb. may be applied to them by increments.

The machine is controlled from a glass-enclosed room, situated at some distance from it. The operator in the control room is in communication with the operator at the machine by telephone. In addition, loud speakers are provided in order that the progress of the test may be announced to a group of students. An elevator is provided whereby assistants may observe the extension or compression of the specimen at any point of its length. The grips for specimens tested in tension are made of nickel-chrome steel and are housed in recesses measuring about 12in. by 24in. in the cast steel crossheads. Each grip weighs nearly 1½ tons. As they are too heavy for manual operation they are fitted with pneumatic cylinders.

Devices are provided for maintaining a constant load on the specimen over an indefinite period, and for applying the load at a constant rate of increment. The motors are controlled by starting, stopping, and inching buttons, and limit switches are provided to cut them out automatically at the end of the safe range of movement.

On January 29th, we are informed, during the testing of this machine, there was broken in it a tensile specimen 8⅛in. in diameter. This specimen fractured under a load of 1381 tons, corresponding to a unit stress on the original section of 27 tons per square inch. The elongation was 19·6 per cent. on 30in., and the reduction of area 22 per cent. On the same day there was crushed a concrete cylinder, 30in. in diameter by 60in. in height. The crushing load was 1317 tons.

DISARMAMENT AND THE ARMAMENTS INDUSTRIES.

AT the First World Disarmament Conference at Geneva the delegates of the principal Powers have one and all advocated drastic limitation of various forms of armament, and it seems as if the final Disarmament Convention will be a stronger document than was anticipated. This fact has made necessary the need for constructive thought as to what is to be done with the displaced workers and the disorganised armaments industry. For that reason the League of Nations Union has organised a Conference, to be held at the London School of Economics on March 1st, 2nd, and 3rd. During the three days the whole range of the relationships between the armaments industry and employment will be reviewed. Starting with a discussion of what the armaments industry may be, it goes on to consider how the money is spent and who does the work. The second day will be devoted to the discussion of the meaning of disarmament to trade, investment, industry, and the community. On the third day there will come up for consideration what may be done to settle the displaced worker nationally and internationally. Tickets for the Conference, which are free, can be obtained from the League of Nations Union, 15, Grosvenor-crescent, S.W. 1. The following are the details of the programme :—

LEAGUE OF NATIONS UNION.

CONFERENCE ON DISARMAMENT AND UNEMPLOYMENT.

Chairman of all Sessions—The Rt. Hon. the Lord Chancellor.

Tuesday, March 1st.—10.15 a.m., welcome by Professor Gilbert Murray, Chairman, Executive, League of Nations Union; 10.30 a.m., "What is the Armaments Industry?" speakers, Sir Holberry Mensforth, Chairman, Manchester District Armaments Output Committee, Director-General Factories, War Office, 1920–26; Mr. John Baker, Iron and Steel Trades Confederation; discussion; 2.30 p.m., "Costs and Employment: How the Money is Spent and Who Does the Work;" speakers, Captain W. S. Sanders, Financial Secretary, War Office, 1929–31; Professor J. H. Jones, Leeds University; discussion.

Wednesday, March 2nd.—10.30 a.m, "What Disarmament Means—to Trade and Investment;" speakers, Mr. Hartley Withers, formerly editor of *The Economist;* Hon. R. H. Brand, Messrs. Lazard Bros. and Co., merchant bankers; discussion; 2.30 p.m., "What Disarmament Means—to Industry and the Community;" speakers, Rt. Hon. Margaret Bondfield, Minister of Labour, 1929–31; Mr. Harold Wright, formerly editor of *The Nation;* discussion.

Thursday, March 3rd.—10.30 a.m., "What Might be Done to Settle the Displaced Worker;" speakers, Mr. Ramsay Muir, Chairman, National Liberal Federation; Mr. John Bromley, President, T.U.C.; discussion; 2.30 p.m., "International Aspects of Disarmament and Unemployment;" speakers, Sir Arthur Salter, Director, Economics and Finance Section, League of Nations, 1919–20, 1922–30; Rt. Hon. A. V. Alexander, First Lord of the Admiralty, 1929–31; discussion.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Inactive Conditions.

THE depression in the iron and steel and heavy engineering industries of the Midlands and Staffordshire persists, and with consequent little activity at the works, business on the iron and steel market lacks vigour. Consumers have satisfied current requirements, and, as there is no evidence of a probable increase in consumption this month, buying has been suspended. Inquiries in various branches of the market lead to the conviction that, in almost every department, the tonnages of material being consumed are small, and there is but little sign of either an early improvement in specifications against existing orders or of the placing of new business of any substantial volume. There is a marked absence of activity in the heavy trades of the district. The various branches of engineering are, with rare exceptions, inactive, and the feeling is that no appreciable improvement is likely to be met with before the middle of March. Black Country tube makers report no improvement in the unsatisfactory trade position. The outlook is poor in all sections of the trade. Stampers are only moderately engaged, but firms producing domestic hardware are fairly well employed as are other light industries, especially in the Birmingham area. A good deal of business in connection with railway development work in foreign and Colonial markets, is in abeyance, through the holding up of big schemes which had been contemplated. Fortunately for this area, other orders have come along and a steady output is being maintained. There has been a marked falling off in the motor industry in this area, and many firms supplying components to the trade are now feeling the position more or less severely. One of the exceptions is the washer industry, which carries on with a steady rate of output. It is anticipated that trade will take a turn for the better in the near future, but, until the new situation created by tariffs has developed further, quiet conditions are likely to rule. There was only a moderate attendance on 'Change in Birmingham this week, and little business was done. There was a poor demand for all classes of iron and steel, whether of British or foreign origin. Selling prices in the main were unaltered.

Raw Iron.

Midland blast-furnacemen are becoming concerned regarding the immediate future. The present unsatisfactory demand shows no sign of improving, and the slackness in the heavy foundries continues. The improved buying, at the beginning of the year, of iron for the light castings trade, which was maintained until recently, gave hope of a prosperous quarter for smelters, but this slump in business has put a different complexion on matters. From all appearances, there is little prospect of a revival in this quarter this month, at any rate. Stocks of iron at the furnaces are being added to present output, being in excess of consumptive requirements. Northamptonshire furnacemen are bidding for business in the northern markets, and are meeting with a little success. For this business they are not bound to Association selling prices, with the result that orders from this source are not usually as remunerative as those from the Midland market. Nevertheless, they are welcome at the furnaces just now. The Central Pig Iron Producers' Association maintains minimum selling rates of Midland pig irons at recent levels. Derbyshire and North Staffordshire No. 3 foundry iron is £3 6s. and Northamptonshire £3 2s. 6d. Forge grades are £3 1s. and £2 17s. 6d. respectively. Prices are per ton delivered Black Country stations, and are subject to a rebate in the case of buyers taking over a certain tonnage per month. Furnacemen are being pressed for higher prices for blast-furnace coke, ovenmen being disinclined to renew contracts at the figures applying to many present contracts. For accommodation lots higher prices have to be paid. Furnacemen contend that if they have to concede higher prices to fuel suppliers they will be obliged to pass the extra charge on to users of iron. The whole question will no doubt come up for consideration at the February monthly meeting of the Association. Up to the present, production of pig iron in this area has been kept up to late rates, but unless there is a speedy improvement in demand some curtailment of output at the furnaces will probably take place.

Manufactured Iron.

The Staffordshire finished iron trade is operating as of late. Ironmasters experience difficulty in keeping the mills operating, either on best iron bars, merchant and common bars or on strip. There has been no movement worthy of note during the past week. Demand for marked bars is irregular, but values are upheld at £12 per ton at makers' works. There is little call for Crown bars and still less for nut and bolt and fencing grade iron, prices of which are £9 5s. to £9 15s. and £8 7s. 6d. to £8 10s. respectively. Mills rolling wrought iron tube strip are employed at about half capacity. Competition for business remains keen, and, while strip is generally quoted £10 12s. 6d., there is little doubt but that many makers would accept £10 10s. for a good tonnage order. Belgian No. 3 iron continues to be offered in this district at attractive rates and the present tariff of 10 per cent. will make no appreciable difference in this department of trade. Ironmasters who have adapted their plant to the re-rolling of steel are better off than their fellows, but even they are not doing as well as they were a month or so ago.

Steel.

There are no encouraging features in the finished steel trade in this area and business just keeps "jogging along." All the large consuming industries are short of work, and engineers in the various branches are in some instances inclined to be pessimistic. All are hoping for better times, however. Prices of structural steel are unchanged, being quoted at the Association figures. Angles are £8 7s. 6d., less 15s. rebate to users of British steel only; tees, £9 7s. 6d., less 15s.; joists, £8 15s., less 22s. 6d.; ship, bridge, and tank plates, £8 17s. 6d., less 15s. Boiler plates, selling prices of which are not controlled, are £8 12s. 6d. In the semi-finished branch business is suspended pending the development of the situation occasioned by the country going Protectionist. Local makers do not appear to have altered their quotations. In Birmingham this week small re-rolled bars were quoted £6 12s. 6d. upwards, and all-British bars £7 5s. Mild steel billets were £5 7s. 6d., sheet bars £5 5s., and Staffordshire hoops £9 10s. Stocks of Continental material are plentiful, and the scarcity of business amongst the merchants indicates the indifference which prevails amongst buyers. Foreign steel has been bought on a fairly heavy scale in recent months, and some time must elapse before supplies contracted for are used up and fresh buying becomes necessary. Further speculative buying may, however, be indulged in later on. Just at the moment business is suspended.

Galvanised Sheets.

Makers of galvanised sheets are meeting with some success in their efforts to uphold selling prices. This week the lower rates mentioned last week "faded out," leaving the higher ones as the general quotations. Galvanised corrugated sheets of 24 gauge are being held for £9 10s. f.o.b., but mills are, comparatively speaking, so thinly supplied with orders that it is questionable whether the competition for business, which has been exceedingly keen since price control in the industry was abolished, will not result once again in the "cutting" of accepted price levels. Overseas demand has improved somewhat of late, but it is below its usual volume, especially from some markets. It is noteworthy that galvanised sheets exported last month were of a value a long way in advance of those of a year ago. While in January, 1931, exports were valued at £295,205, in January this year the amount was £341,162. Many of the inquiries in circulation just now come from the Balkans. The home trade holds good, and helps mills to keep going.

Tin-plates.

More interest is being taken in this area in the tin-plate department, for the trade is making a distinction between current and forward quotations. Buyers who are prepared to take prompt delivery can get supplies at from 13s. 9d. to 14s., whereas the price quoted for April delivery is 14s. 6d. There has been some improvement in buying.

Scrap.

There is not much movement in the scrap market at date, the present position being considered somewhat difficult. Prices of steel scrap are low, and merchants are very loth to part with material on the present terms. Many of them have heavy stocks, however, and would like to be relieved of some portion of them. It is reported that several firms have bought heavily in the hope that an improvement in trade will set in before long with a consequent jump in values.

Production.

Satisfaction is expressed with the iron and steel production figures for January and with the recorded increase in the number of active blast-furnaces. The output of the pig iron furnaces in January amounted to 332,400 tons, compared with 330,600 tons in December and 337,200 tons in January, 1931. Production included 82,400 tons of hematite, 126,900 tons of basic, 103,100 tons of foundry, and 12,100 tons of forge pig iron. There were seventy-six furnaces in blast at the end of January, a net increase of six compared with the number in blast at the end of December. The output of steel ingots and castings was also up, amounting as it did to 429,700 tons, compared with 425,400 tons in December and 402,200 tons in January, 1931.

Trade Returns.

The January trade returns are welcome, insomuch as they show a smaller volume of imports, but it is noticeable that exports remain at a low level. Comparisons of the returns of the months of December last and January show that imports of raw materials fell in value from £18,475,334 to £16,893,191, and manufactured goods from £18,195,878 to £13,304,974. Although the total value of British exports last month was nearly £1,000,000 below the total for December, there was a slght improvement in exports of manufactures, from £22,661,836 in December to £23,423,015 in January, largely owing to an increase of nearly £600,000 in exports of cotton yarns and manufactures. By comparison with January, 1931, all classes of manufactured exports showed a decline in value last month, nearly £1,500,000 of a total reduction of £5,298,000 being accounted for in the vehicles group—including ships. The total quantity of iron and steel imported during the month was 170,435 tons, valued at £1,065,459, compared with 221,773 tons and £1,610,399 in the corresponding month of last year.

Rolling Stock.

Two Black Country firms are amongst those who have participated in the orders for four-wheeled tipping wagons recently given out by the Chinese Government Purchasing Commission in London. W. G. Allen and Son, Ltd., of Tipton, are to supply 400 wagons, and Alfred Allen and Son, Ltd., of Dudley, 100.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Textile Machinery's Better Start.

EXPORT business in textile machinery during the first month of the year was heavier, both as to quantity and value than it was in January, 1931, and the figures were also appreciably above the monthly average for last year. Shipments during the month under review totalled 5911 tons, valued at £523,202, compared with 4898 tons and £515,858 in January of last year, and 9060 tons and £863,671 in the corresponding period of 1930. Last month's exports included 4046 tons of spinning and twisting machinery, valued at £365,088, and 1343 tons of weaving machinery, valued at £95,553. In spite of continued serious political trouble in India, that country still heads the list of markets for British textile machinery, the January shipments thence reaching a value of £170,190. China is a very poor second with £38,754, followed by Japan, £37,517, South America £30,731, Russia £23,650, the Netherlands £22,024, Germany £15,973, France £13,952, the United States £11,324, and Australia £5550. Aggregate shipments to "other European countries" registered an improvement to £121,591, against £103,890 a year ago.

Industrial Results.

Statements of several leading engineering concerns issued during the past week reflect the unsatisfactory trading conditions of the past year. The available profit in the case of Mather and Platt, Ltd., of Newton Heath, Manchester, has not yet been announced, but the reduction in the dividend on the ordinary shares from 10 per cent., tax-free, for 1930, to 6 per cent., less tax, for last year, indicates a substantial reduction. Crossley Brothers, Ltd., of Openshaw, Manchester, in 1930 made a profit of £30,205, but for 1931 there was a loss of £59,672. The directors report that the world economic crisis has caused a serious contraction in the company's export trade, which is normally the chief source of its trading revenue. The report of Burnell and Co., Ltd., of Ellesmere Port, discloses a profit reduced to £835 for the past year's working. It is emphasised that throughout the year the demand for galvanised steel sheets for export has continued much below normal. This has resulted in an excess of manufacturing capacity over the present demand, and competition for business has, therefore, been severe and prices have continued low. Since the departure from the gold standard on September 21st, the report states, there has been some improvement in demand, both in the home and export markets, and the working result of the second half-year was more profitable to the company than was the January-June period.

Obituary.

The death has occurred, at the age of sixty-eight years, of Mr. William Taylor, managing director of Buckley and Taylor, Ltd., of the Castle Ironworks, Oldham. Mr. Taylor was a member of the executive council of the National Federation of Engineering and Allied Employers.

Non-ferrous Metals.

A recovery in values in all sections has characterised the non-ferrous metals market during the past week. In no small degree, the advance in prices during the last few days may be attributed to the influence of the greater activity on the New York Stock Exchange, although, at the same time, it should be stated that the low levels to which the metals had fallen a week ago have proved an attraction to "bullish" speculators, whose operations have contributed towards the recovery. Statistically the tin position hardly favours higher rates, for heavy stocks of the metal are held, and up to the present the operations of the tin pool have had little apparent influence on the situation. Principally, for the reasons stated, however, values are higher on balance to the extent of £1 5s. a ton. Trade buying in the copper market has been of limited dimensions, but after considerable fluctuations in the course of the week, standard brands have finished up dearer by about £1 12s. 6d. per ton. The biggest advance relatively has been in the lead section. Buying interest, primarily on foreign account, has been rather more active, and the week's rise of £1 a ton has brought quotations back to where they were five weeks ago, all the losses in the intervening period having been recovered. Spelter is roughly 10s. a ton dearer on balance, without, however, any appreciable improvement in the demand from consumers.

Iron and Steel.

Extremely dull conditions have ruled in the iron and steel markets, and in the early days of this week there appeared to be a return of the depressing atmosphere noticeable two or three weeks ago. The order books of most general founders in the Lancashire area are unsatisfactory and few of them are able to look any distance ahead, even on the basis of their present reduced scale of operations. Consequently, there is little disposition to enter into forward contracts, and there is a growing fear that buying for early delivery will become almost a general rule as present contracts run out. So far aggregate deliveries to foundries in the district are maintained at a reasonably satisfactory level, but there is an impression that much of the pig iron that is being delivered now is going into stock. Prices are firm on the basis of 67s. per ton, delivered equal to Manchester, for Derbyshire, Staffordshire and Cleveland brands, 65s. 6d. for Northamptonshire, about 87s. for Scottish, and 81s. for West Coast hematite. Bar iron prices, also, are steady, with Lancashire Crown bars at £9 5s., and No. 2 material at about £8 5s., but buying interest continues at a disappointing level. No big constructional jobs are coming the way of Lancashire firms in this branch, although the position of one or two is said to have been improved a little by the placing of small contracts. In most other respects, the steel-using industries locally are no better situated than before, and almost the whole of the limited buying just now is on a strictly early rolling basis.

BARROW-IN-FURNESS.

Hematite.

There is distinct quietness in the hematite pig iron market, and the little improvement noted a month or two ago has not been maintained. The lack of orders for the steel departments in the shape of railway material has reduced the local iron requirements, locally, very considerably, and that has meant more iron going into

stock. The Barrow furnaces will go out of blast this week owing to so few orders for delivery being received. As a matter of fact, the only furnace in blast in the Furness district will be the one at Backbarrow, which is engaged on special qualities of iron. Trade, generally, in this country is very dull, as reflected by the small orders received from customers. The cheapness of hematite iron abroad does not seem to tempt buyers, and it can be taken from that that foreign customers are not requiring much, if any, iron at present. The home demand is very thin. The iron ore market is naturally affected by the putting out of furnaces and business will be as low as it has been for many years. The steel market is very quiet. The rail departments at Barrow are idle, but at Workington certain contracts will keep the mills going for a period. The general outlook is very dull and there are no signs at present of an improvement.

SHEFFIELD.

(From our own Correspondent.)

The Heavy Steel Trades.

THE general position of the local steel trades shows no improvement, and most sections are suffering from considerable depression. This applies especially to the production and heavy manufacturing sides. At the open-hearth furnaces, output is being maintained at recent levels, but there is increasing difficulty in finding an outlet for it. Business is still largely of a hand-to-mouth character, and orders for bulk quantities or for forward delivery are very scarce. In the manufacturing sections, the production of large hollow forged boilers and other drums still provides a good deal of employment, but shipbuilding steel is in poor demand, and the shops devoted to the production of railway axles, tires, and springs are very short of work. The only work of importance on hand in the heavy engineering section consists of steel works plant for Russia, and it is likely to provide occupation for some considerable time. The firm executing it has carried out several important orders for Russia in the same line, which kept it busy last year.

The Lighter Side.

The production of stainless steel is on a considerable scale, though it has lately shown some falling off from previous high levels. The demands of the automobile industry keep up moderately well, and provide a good deal of work for several firms. One of the most progressive of the ligher branches, at present, is that of cold-rolled steel and strip, which, helped by the fall in the value of the pound, is now being produced at a price which can hold its own against foreign competition. Other light trades are benefiting from both the exchange position and from the anti-dumping duties, with the result that an increasing volume of orders is being booked for twist drills, cutters, files, hack saws, precision tools, scissors, surgical instruments, lawn mower knives, and other classes of finished goods. For lawn mower knives, the demand is exceptionally good. The heavy duty imposed upon cheap foreign mowers has brought a number of new brands of machines into the market, and this year's output is the largest on record. All the blades are being supplied by Sheffield firms. For certain classes of tools, apart from those specified, demand is quiet. The situation is affected adversely by the existing large stocks of foreign goods, but it is confidently believed that, when those stocks are worked off, a growing amount of business will come to Sheffield. Engineers' requirements in tool and tool steel have shown a considerable falling off.

A Rolling Expansion.

An increase in its comprehensive range of productions has been brought into operation by the Frodingham Iron and Steel Company, Ltd.—of the United Steel Companies, Ltd. Until recently it has omitted certain standard beam sections from its list, owing to practical difficulties in rolling some of the sections in its existing mill. It has now determined to place itself in the position of being able to supply the complete range of British standard beams, and is successfully rolling 22in. by 7in. and 24in. by 7½in. beams. In order to carry this out certain mill alterations were necessary. The finishing mill is a 30in. one, and the rolling of these large sections from a mill of that size is an interesting technical achievement.

Cast Iron Roads.

Another interesting development has been introduced by the Stanton Ironworks Company, Ltd. During the past eighteen months it has been making cast iron road sections, which it has tried out under heavy commercial traffic conditions at Stanton, West Ham, Islington, and Millwall. The sections are now being put on the market. When laid on a concrete foundation, they are intended to meet the difficult conditions encountered in present-day road-making practice, and to give a permanent roadway, with freedom from wear. It is claimed that they are more durable than granite setts, and they have the additional advantage of being some 20 per cent. cheaper.

Hopes of New Works.

The Sheffield Industrial Development Committee, which represents the City Council, Chamber of Commerce, Cutlers' Company, and University, is actively engaged in dealing with inquiries with regard to works and works sites, and in compiling a list of the city's facilities in those directions. An illustrated booklet, comprehensively setting forth the advantages which Sheffield offers to those contemplating the establishment of new works, is about to be issued. Penistone, which has suffered severely from trade depression since the closing of the English Steel Corporation's works two years ago, is hoping to see a new enterprise established in its midst. The Urban District Council has received an inquiry from a Sheffield firm concerned in the manufacture of engineering and electrical products, which at present imports goods from abroad, that it proposes to manufacture in England. It is stated that, if the negotiations are successful, and a works is started, employment will be found for 300 people at the outset, and for 1000 later. The firm is reported to have suggested that the Council should erect a five-storey building, for which it would pay rent, and on the plant and equipment of which it would be prepared to spend about £60,000. The Council of Holmfirth has also received an inquiry from a Sheffield firm—Messrs. Clifton and Co., engineers—who are on the look-out for a site for a factory for the engineering and allied trades, the area required being from 5 to 10 acres. The Council decided to call the firm's attention to a site which is considered very suitable.

Low-temperature Carbonisation.

Sheffield is closely associated with the development of Commendatore Salerni's system of low-temperature carbonisation, the experimental work on which was done in the laboratories of the city's University, and a description of the system, which the inventor has written, is therefore of much interest. Commendatore Salerni states that the system consists in heating to a temperature of about 450 deg. Cent. by the external application of heat, in a retort of the revolving drum type, a blend of comminuted coal and semi-coke, so finely ground that its porous structure is destroyed, pitchy fractions of the oil from the process itself being added to the blend. The mixture is introduced at one end of the drum, travels through it, and is discharged at the other end in the form of coke; introduction, travel, and discharge taking place continuously by gravity action. On reaching the temperature at which coking begins, the charge tends to form itself into spheroidal blocks. The retort is a cylindrical rotary furnace, resting on rollers, and driven in the usual manner. Fires and explosions are stated to be impossible. The retort is 70ft. long, of an internal diameter of 4ft. 8in., and will have, with average coal, a capacity of 100 tons of raw coal a day. It is so designed that it can be built in much larger units. Enumerating the characteristics and advantages of his system, Commendatore Salerni states that, without involving the production of any surplus gas, a smokeless fuel, in blocks of useful size only, without breeze, of good mechanical strength, of a density, calorific value, and flaming property approximating to those of the original coal, and therefore a satisfactory substitute for that coal, can be produced from any bituminous coal. The oil obtained is a true primary oil, rich in the lighter fractions, free from dust and pitchy constituents, and therefore easy to treat by ordinary refining methods by cracking or by hydrogenation.

Better Cutlery Figures.

The cutlery trade remains quiet, and few firms are well employed. At the same time, the aggregate output is substantial. A pleasing feature is that imports in January fell to the low figure of £6426, as compared with a monthly average in normal times of from £38,000 to £40,000. This suggests the likelihood of an increase in home trade when the large foreign stocks in this country become depleted. Recent levels of export are maintained. Although the January figure of £47,642 was rather less than that of December, it was £2000 better than that of January last year. There was a falling off in knives and razor blades, but a good increase in safety razors and scissors. Shipments to Australia showed an improvement, which, though not large, is welcomed as an indication that the worst of the slump in that market may have been passed.

A Village Water Scheme.

A scheme of water supply to nine Trentside villages, to cost no less than £43,250, is proposed by the Brigg Rural Council. The villages are in the neighbourhood of Brigg and Scunthorpe, and it is proposed to operate the scheme from two bores, one of which would be at Winterton, near Scunthorpe, and will be capable of a daily yield of 1,000,000 gallons, while the other, at Scawby, near Brigg, would have half that capacity.

NORTH OF ENGLAND.

(From our own Correspondent.)

Trade Recovery.

IT is just possible to record further slight progress along the difficult road of trade recovery. The movement, it must be admitted, is extremely slow, particularly in the heavy iron and steel industries, but it is gradually taking shape, and it justifies confidence in a continuous, steady improvement. Conditions, both at home and abroad, are not such as to warrant any hope of a rapid revival, even if it were altogether desirable; but it is at least possible to discern a brightening of the position which points definitely to the end of the long night of trade depression. Confirmation of this view was forthcoming in a conversation I had this week with a director of one of the leading firms of iron and steel producers on Tees-side: "There has been a little more buying in the home market, and one or two new avenues for trade abroad have been opened out," he said, "but the improvement can certainly not be regarded as substantial. Still, matters are moving in the right direction, and, when the tariff system becomes operative and settled, I feel convinced that trade will expand on encouraging lines." Considerable interest is being taken by steel producers in this district in the proposal of the London County Council to adopt new by-laws, in which the use of steel in buildings is the principal recommendation. Already thousands of tons of Cleveland produced steel have been used in the erection of some of the largest buildings in London, but, should the Council's recommendation become operative, it will result in a greater demand for a special high-tension material produced in the Cleveland area. Producers welcome the move, because it might be the precursor to a development of the more general use of steel in building throughout the country.

Cleveland Iron Trade.

There has been more life in the Cleveland iron market this week than for some months past. Confidence is returning, inquiries are more numerous, actual sales are on a better scale, and specifications against contracts are being more freely released. Current output is going into immediate consumption, and stocks are still being drawn upon to meet requirements. A considerable proportion of the iron stored at makers' yards is sold, and buyers are expected to accept deliveries more freely than of late. Makers are expecting to arrange further contracts with Scottish consumers, despite keen competition. Prices are steady and firm, No. 1 Cleveland foundry iron being 61s., No. 3 G.M.B. 58s. 6d., No. 4 foundry 57s. 6d., and No. 4 forge 57s.

Hematite Pig Iron.

The East Coast hematite pig iron trade shows little change on the week. Consumers continue to seek price concessions, though makers protest that rates obtainable are unremunerative. Merchants have still substantial holdings to dispose of and readily accept orders on the basis of ordinary qualities at 64s. No. 1 quality is at a premium of 6d. per ton.

Ironmaking Materials.

There is no demand for foreign ore, but relief is expressed that imports are to continue duty free. Blast-furnace coke is a dull market at 17s. delivered at the works.

Manufactured Iron and Steel.

The feature of the manufactured iron and steel trade is a brisk buying movement in the sheet section, under the influence of which black sheets, 24 gauge, have advanced to £8 5s., and galvanised corrugated sheets, 24 gauge, to £10 5s. per ton. Two or three other sections of the trade are also more active.

The Coal Trade.

There is little movement in the Northern coal trade, and the outlook has no cheering feature. The winter is well advanced, and stocks of fuel at home and abroad are heavy owing to the mild weather and the general depression in trade. New business for the remainder of February and for the first half of next month is scarce, and contractors' demands are severely limited by the restriction of imports into Germany and other countries. It is impossible to clear commitments as a result of these unforeseen official actions, and, consequently, an abundance of coal is on offer either direct or through second-hand holders. The output at most of the collieries is being limited, but there is still no scarcity of supply on the open market, and, with only odd exceptions, every description is obtainable at rock bottom minimum. Best Northumberland steams are quoted readily at 13s. 6d., and Tyne prime at 13s. Small steams are quiet at 8s. 6d., secondary small at 8s., and Tyne best at 9s. The position is steadily becoming disheartening in the Durham coal field. Demands under existing contracts for shipment to the Continent are being cut down daily through import restrictions, while the home demand shows no expansion. Idle time seems likely to be even more pronounced for the remainder of this month at most of the Durham collieries. Fitters are offering every description abundantly, the minimum being weakly indicated. Best Durham gas coals are quoted at 14s. 6d., and secondary at 13s. 6d. Durham coking unscreened are pressed on the market at 13s. to 13s. 9d., and coking small at 12s. 6d. to 13s. 3d. The best grade of bunkers are well booked to the end of the month, and quoted sparingly at 13s. 9d. to 14s. 3d., but second sorts are dull and easy in tone at 13s. The coke trade position is gradually easing under a slowing demand. Stocks on the Continent are now reported to be substantial, and owing to weather conditions holders are anxious to clear them off before buying further quantities. The demand for early shipment is quieting down, and prices move in buyers' favour. The reductions in price so far are merely nominal, but the undertone is not bright. Gas coke is steady at 19s. Coke nuts, while firm for prompt, are quoted easier forward at 19s. to 20s. Patent oven coke is a slow trade and values easy at 16s. to 16s. 6d., and for superior coke at 18s. to 20s.

American Inquiries for Coal.

Possible buyers of coking coal for industrial use in the United States and Canada have been on Tyneside this week making investigations as to quality, prices and freight. At the present rates of exchange the chances, for at least a little new trade are considered good. Nothing has been done yet, and much will depend on the results from the first cargoes should they be negotiated. As may be imagined, in these difficult days, when so many of the old channels of business have been limited by restrictions on imports, both collieries and merchants are keen to explore any fresh avenue for orders.

SCOTLAND.

(From our own Correspondent.)

Continued Quietness.

So far as business is concerned, the position on the whole in the steel, iron, and coal markets is unchanged, and without any special feature of encouragement. It has been said that since the announcement of a 10 per cent. import duty a more hopeful feeling has been apparent, but, until the position as regards exemptions becomes more definite, and the possible effect of the duties and exemptions more clearly demonstrated, consumers are not likely to enter into the markets to any greater extent than at present. It has also been said that a 10 per cent. tariff is insufficient to limit importations of steel and iron to any appreciable extent, if at all. Meanwhile, markets are quiet throughout, though inquiries on foreign account have shown a tendency to increase.

Steel.

It is estimated that very little more than 30 per cent. of the plant capacity is in operation at present. Heavy steel is particularly quiet, plates and sections being neglected. Steel sheets, on the other hand, are comparatively busy. Bookings have been good, especially for the lighter gauges, and inquiries are maintained. Heavy sheets are slow and galvanised descriptions have an irregular demand. Owing, it is stated, to the unremunerative level of prices and higher costs of production, quotations have been advanced 5s. per ton for black sheets ¼in., and 10s. per ton for galvanised sheets, 24 b.g., the former being now £7 15s. per ton home and export, and the latter £10 15s. home and £10 per ton export. The position in the tube trade has not improved to any extent, and the situation continues to be most unsatisfactory.

Iron.

The inquiry for bar iron does not show any tendency to increase, and business remains stagnant. Re-rolled steel bars are hardly any better off. Prices have been, and are being, cut, but specifications are few and far between. In this department, too, higher costs of production are likely to be met with. The number of pig iron furnaces in blast remains at five, with the output still more than sufficient to meet all demands. There were no imports of pig iron into this district last week. Exports from Glasgow amounted to 174 tons (164 foreign), compared with 326 tons (195 tons foreign) in the same week last year.

Scrap.

The demand for scrap is rather irregular. Cast iron machinery is easier at 52s. 6d. to 55s. per ton, and heavy steel unchanged at 40s. to 42s. 6d. per ton.

Coal.

The depression in the Scottish coal trade continues unabated. Though prices for shipment have declined, present levels are evidently still too high to interest overseas importers. Apart from the difficulties of doing business with Continental countries, it is said that stocks abroad are probably comparatively heavy. In any case, shipments are confined to small lots for prompt or early shipment. Consequently, the market is dull and the tendency still weaker. All descriptions of round fuels and washed materials are plentiful. Lothians steams are particularly quiet. Aggregate shipments amounted to 228,367 tons, against 215,145 tons in the preceding week, and 176,607 tons in the same week last year. Home demands are exceedingly poor, owing to industrial depression, and the continuance of unusually mild weather conditions. Even the slight spell of frost has not induced merchants to increase purchases, as their stocks are large and demands will probably decrease with the lengthening days.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

French Surtax on Coal.

THE best news of the week is the intimation received by the British Government that the French Government intends to exempt British coal from the operation of the 15 per cent. surtax. The deputation of coal-owners and coal exporters which waited on the French Government in Paris last week, with reference to the operation of the quota and the surtax, had practically no good news to announce regarding the result of its interview; but it is evident that the discussion did some good. The British Government, in announcing its tariff proposals, might have discriminated against French pitwood, seeing that this country is not dependent upon France for her requirements; but, instead of doing that, the British Government has excluded pitwood, and, incidentally, iron ore, from the list of imports to be affected by the 10 per cent. *ad valorem* duty. Probably the French Government has appreciated that fact and has responded by now exempting British coal from the scope of the 15 per cent. surtax. That, of course, is all to the good, though it may be said that, as the operation of the quota still exists, imports of coal into France will be still limited to the 64 per cent. of the average monthly quantities imported in the years 1928–30, and that, therefore, the United Kingdom will not benefit materially. The assumption, of course, is that this country has been getting its full quota, but investigations show that that is not so. On his return to London from Paris last week, Mr. W. A. Lee, secretary of the British Coal Council, stated that it was admitted by the French Mines Department that about 500,000 tons of coal in excess of the quota had gone into France from countries other than the United Kingdom, and the opinion of coalowners and others on this side of the Channel is that the actual figure is much higher than that. Doubtless it was the intention of the French Government, when it introduced the quota system, that each country should get its fair quantity; but, unfortunately, it did not work out in practice. When French importers of coal receive their licenses they are not told where they are to obtain their supplies from; they look round to see where they can make the best purchases, and, consequently, many of them have placed their coal requirements with German, Polish and Belgian producers, whereas formerly, they would have come to the United Kingdom, but this country has been handicapped in quoting for business by the fact that its fuel has been burdened with the 15 per cent. surtax, which did not apply to coals from any other country. Furthermore, this surtax applied not only to British coals going into France, but also to coals going to any of her Colonies or Dependencies. Now that the surtax is to be removed, British coals will have a fair and better chance to compete for French consumers' requirements, and it is hoped that, in future, coalowners and coal exporters will be able to ship coals up to their full proportion of the quota, whereas, formerly, they have not been able to do so.

The Coal Trade.

Conditions in the coal industry have unquestionably been unsatisfactory during the past week or so, and it is difficult to see how exports from this area for February can show any improvement upon the figures for January, which were lower than those for December, itself the worst month for the whole of 1931 with the exception of January. The position is that South Wales is exporting little more than half the quantity she was sending away two years ago, which is cause enough for anxiety. Last week, according to the Great Western Railway Company's returns, the total for the six ports under its control was 363,315 tons, which compared with 363,735 tons for the preceding week, and with 421,289 tons for the corresponding period of last year. Work is very irregular in the steam coalfield, and the anthracite trade is also not as good as formerly. At the end of last week, the dock returns showed that the number of vacant loading berths was no less than forty-five, and only two vessels were waiting to berth at Port Talbot. This week started with the number of vacant berths at thirty-four, all of which, with the exception of one, were at Newport, Cardiff, Penarth and Barry, where steam coals are shipped. Collieries cannot, of course, work anything like regularly with such a limited outlet for their production, and certainly the volume of chartering of late has been nothing like sufficient to improve their position. The current inquiry from abroad is very restricted. In the case of Spain, the depreciation of the peseta is undoubtedly checking operations, and it is reported that it is on that account that the Norte Railways have not contracted for supplies as they were expected to do, having asked for quotations for about 15,000 tons of steam coals for early delivery. The Andaluces Railway is, however, reported to have made purchases for supplies ranging up to the end of October, while other business is rumoured to have been fixed up for Welsh coals for delivery at a North Spanish port, but, for prompt shipment, operations hang fire. A little business has been done for Rio de Janeiro, but, as the result of inquiries, it is disclosed that other cargoes for other directions which were expected to be placed, have been postponed. Prices have gone in for supplies for delivery at Lisbon at the end of this year, and the early part of next, and the result of the tendering is now awaited.

Coal-trimming System.

Reference has been made to the proposals put forward by the employers for a revision of the system under which coal-trimmers are employed, the idea aimed at being to secure more efficiency and contribute towards improved despatch of steamers. The main proposal is that the coal-trimmers should be under the direct control of the shipowners. The men have discussed the suggestions put forward and have decided to take a ballot. The matter was discussed on Monday at a meeting of the Joint Control Board at Cardiff, when it was reported that negotiations were still proceeding between representatives of the two sides, and the meeting was adjourned pending the result of the ballot. It is understood that the men's leaders are recommending the coal-trimmers to accept the employers' proposals for a revision of the system in operation, subject to the leaders securing certain assurances from the shipowners regarding the question of recruitment, dismissals, &c.

Back to Coal Movement.

The effort to persuade the Government to revert to coal for use on naval vessels is being continued, and the memorial prepared by the Committee has been despatched to the Prime Minister and Members of the Cabinet. It bears the signature of the Lord Mayor of Cardiff and the three honorary secretaries. This memorial sets forth the reasons why there should be an immediate reversion from oil to coal and the importance of relying on home resources, especially at the present time when the appeal is so popular to "buy British goods."

Swansea as Passenger Port.

Messrs. Elders and Fyffes, in addition to utilising Swansea as a bunkering port, are now taking advantage of the port for the embarkation of passengers. The first steamer to do so was the s.s. "Coronado," which sailed on Tuesday for the West Indies, the number of passengers being about forty. So far, the bunkering experiment at Swansea has proved a success, but, according to an official of the firm of Messrs. Elders and Fyffes, the crucial testing time will come about the end of May, when the company will have six or seven of its steamers of the "Coronado" class at the port in a week.

Current Business.

The inquiry for all descriptions of coal continues to be quiet, but as the result of the recent cold snap there has been a rather better demand from France for prompt cargoes. These have, however, been easily dealt with, and a good deal more business is necessary to impart real activity to the industry. The inland demand is also slightly better. Prices all round remain at the minima. Coke and patent fuel display no new feature, while pitwood continues on the easy side at prices ranging from 21s. to 21s. 6d. for Portuguese supplies, and about 24s. for French wood.

LAUNCHES AND TRIAL TRIPS.

STEEL LIGHTER; built by Richard Dunston, Ltd., Thorne, near Doncaster; dimensions, 75ft. by 20ft. by 9ft. 6in.; to carry grain; launch, February 10th.

COURLAND, single-screw steamer; built by Barclay, Curle and Co., Ltd., to the order of Leith, Hull and Hamburg Steam Packet Company, Ltd.; dimensions, 250ft. by 38ft. by 24ft. 9in.; to carry cargo and passengers. Engines, triple-expansion, 21in., 34in., and 56in. by 39in. stroke, pressure 156 lb. per square inch; constructed by the builders; trial trip, February 13th.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. L. A. LEGROS asks us to announce that he has changed his address to 3, Maxwelton-avenue, Mill Hill, N.W. 7. Telephone: Mill Hill 1860.

MR. H. D. WILKINSON, having entered into association with the firm of Messrs. Mackness and Shipley, has moved from his offices at 56, Victoria-street, S.W. 1, to Parliament Mansions, Victoria-street, S.W. 1.

COLONEL CHARLES F. HITCHINS, D.S.O., M.I. Mech. E., M.I.N.A., asks us to announce that he has resigned his appointment as one of the managing directors of Sir W. G. Armstrong, Whitworth and Co., Ltd.

MESSRS. MACKNESS AND SHIPLEY ask us to announce that they have changed their address from 28, Victoria-street, to Parliament Mansions, Orchard-street, Victoria-street, London, S.W. 1. Their telephone number remains unchanged, viz., Victoria 9355.

MR. W. P. BRADBURY, Road Transport Assistant to the Passenger Manager of the L.M.S. Railway, has been appointed Chairman for the present year of the Huddersfield Corporation and L.M.S. Railway Joint Omnibus Committee, which controls the joint omnibus services in Huddersfield and district.

WILD-BARFIELD ELECTRIC FURNACES, Ltd., asks us to announce that the manufacturing and selling rights of the Vickers Works projection microscope have been taken over by Cooke, Troughton and Simms, Ltd., and that Wild-Barfield Electric Furnaces, Ltd., has been appointed distributor.

CONTRACTS.

SIR WILLIAM ARROL AND CO., Ltd., of 59, Palace-street, Victoria-street, Westminster, has received from the Rhodesia Railways, Ltd., 2, London Wall-buildings, London, E.C. 2, an order for an 80-tons overhead electric travelling crane, for the Railway Workshops at Mafeking.

RICHARD CRITTALL AND CO., Ltd., of London and Braintree, has received an order to supply for the new Benito Mussolini Tuberculosis Hospital in Rome, the British Panel Warming System, which was patented and is controlled by that firm. The order was given after an exhaustive inquiry made by an Italian Commission, which visited this country for the purpose. The new building will contain nine wards with accommodation for 2500 patients, as well as administrative buildings.

THE VAUGHAN CRANE COMPANY, Ltd., asks us to draw attention to the fact that its address is Openshaw, Manchester, and not Wolverhampton, as stated in our issue of February 12th, under the heading "Contracts" recently entered into by the Great Western Railway Company. The Vaughan Company has also recently received orders for cranes of various types from the East India, the Southern, the Great Western, and the L. and N.E. Railway Companies, and from the London Power Company.

CATALOGUES.

GLENFIELD AND KENNEDY, Ltd., Kilmarnock.—New edition of a pamphlet on electrically operated sluice valves.

TAYLOR BROS., Castleton, Manchester.—A detailed catalogue of friction clutches for all classes of power transmission.

RANSOMES AND RAPIER, Ltd., Ipswich.—"What We Make," giving brief illustrated particulars of the firm's products.

MARSHALL, SONS AND CO., Ltd., Gainsborough.—"Some Notes on the Marshall Britannia Works and Manufactures."

BRUSH ELECTRICAL ENGINEERING COMPANY, Ltd., Falcon Works, Loughborough.—Publication on "How a Power Company Uses Brush Transformers."

ASBESTOS CEMENT BUILDING PRODUCTS, Ltd., Trafford Park, Manchester.—A booklet illustrating a large number of buildings on which "Turner's Trafford Tiles" are used.

BELL'S ASBESTOS AND ENGINEERING SUPPLIES, Ltd., Bestobell Works, Slough.—A 548-page general catalogue covering the firm's products, also a descriptive booklet on the "Aga" cooker.

NEGRETTI AND ZAMBRA, 38, Holborn-viaduct, E.C. 1.—A booklet on the mercury-in-steel thermometer; also leaflets on automatic temperature regulators, edgewise thermometers, recorders, &c.

W. CANNING AND CO., Ltd., 133–137, Great Hampton-street, Birmingham.—Eleventh edition of "The Canning Practical Handbook on Electro-plating, Polishing, Bronzing, Lacquering, and Enamelling."

BRITISH STEEL PILING COMPANY, Ltd., 54A, Parliament-street, S.W. 1.—"Steel Sheet Piling," a brochure illustrating and describing a large number of works in which "Larssen" steel sheet piling is used.

DAVID BROWN AND SONS (HUDDERSFIELD), Ltd., Lockwood, Huddersfield.—The second edition of the "David Brown Hob Book," containing particulars of more than 2000 hobs. The price of this book is 1s.

STERNOL, Ltd., Royal London House, Finsbury-square, E.C. 2.—"Lubrication of Diesel and other Types of Heavy Oil Engines," dealing with the latest developments of the high-speed heavy oil engine used for land, marine and road transport.

BRITISH OXYGEN COMPANY, Ltd., Angel-road, N. 18.—Catalogue Section 3 of oxy-acetylene equipment for welding, hand cutting and surface heating of metals. Section 4 of "Alda" welding materials, rods, fluxes, electrodes, &c., for gas and electric arc welding processes.

IGRANIC ELECTRIC COMPANY, Ltd., 149, Queen Victoria-street, E.C. 4.—Leaflets on "Automatic Starting and Speed-regulating Rheostats"; "Pedal-operated Controllers"; "High-duty Lifting Magnets"; "Reversible Rope-operated Drum Controllers"; "Magnet-operated Brakes for D.C. Service."

FARADAY HOUSE ELECTRICAL ENGINEERING COLLEGE.—The annual examinations for a Faraday Scholarship of eighty guineas per annum, tenable for two years in college and one year in manufacturing works, and for a Maxwell Scholarship of sixty guineas per annum, tenable for two years in college and one year in works, will be held at Faraday House on April 5th, 6th, and 7th, 1932. Exhibitions may also be awarded to candidates who acquit themselves creditably in the above examinations, but who do not obtain the necessary number of marks to qualify for the Faraday or Maxwell Scholarship. The subjects of examination for the Faraday Scholarship are geometry, algebra, trigonometry, dynamics, statics and hydrostatics, geometrical and free-hand drawing, chemistry and physics. For the Maxwell Scholarship the subjects are mathematics, dynamics, statics and hydrostatics. Further particulars may be obtained from the Registrar, Faraday House Electrical Engineering College, 62–70, Southampton-row, London, W.C. 1.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	16/6 to 20/–
(1) Spanish	17/– to 21/–
N.E. COAST—	
Native	18/– to 21/–
Foreign (c.i.f.)	16/6 to 17/–

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 8 6	—
No. 1 Foundry	3 12 0	—
No. 3 Foundry	3 9 6	—
N.E. COAST—		
Hematite Mixed Nos.	3 4 6	3 4 6
No. 1	3 5 0	3 5 0
Cleveland—		
No. 1	3 1 0	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
MIDLANDS—		
(c) Staffs.—	(*Delivered to Station*).	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 1 0	—
,, ,, Foundry	3 6 0	—
(c) Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
(c) Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	3 15 6 (a); 4 0 6 (b); 4 5 6 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	9 15 0	9 5 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 5 0	—
Common Bars	10 10 0	—
Best Bars	11 0 0	—
Double Best Bars	11 10 0	—
Treble Best Bars	12 0 0	—
LANCS.—		
Crown Bars	9 15 0	—
Second Quality Bars	8 5 0	—
Hoops	12 0 0	—
S. YORKS.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	9 5 0 to 10 7 6	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 7 6	—
Gas Tube Strip	10 10 0 to 10 12 6	—

STEEL. (d)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates (Marine)	9 0 0	8 10 0
,, ,, (Land)	—	—
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	7 15 0	7 15 0
Sheets (Gal. Cor. 24 B.G.	10 15 0	10 0 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
,, ,, (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
MANCHESTER—		
Bars (Round)	9 7 6	—
,, (Small Round)	7 0 0	—
Hoops (Baling)	10 0 0	9 15 0
,, (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
,, (Lancs. Boiler)	8 15 0	—
SHEFFIELD—		
Siemens Acid Billets	9 2 6 (basis)	—
Hard Basic	8 2 6 and 8 12 6	—
Intermediate Basic	6 12 6 and 7 2 6	—
Soft Basic	6 0 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	7 10 0	—
MIDLANDS—		
Small Rolled Bars (all British)	7 5 0 to 7 15 0	—
Small Re-rolled Bars	6 12 6 to 6 15 0	—
Billets and Sheet Bars	5 7 6 to 5 10 0	—
Galv. Sheets, f.o.b. L'pool	9 10 0	—
(2) Staffordshire Hoops	9 10 0	—
(d) Angles	8 7 6	—
(d) Joists	8 15 0	—
(d) Tees	9 7 6	—
(d) Bridge and Tank Plates	8 17 6	—
Boiler Plates	8 12 6	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14 f.o.b.	14/3 to 14/9
Block Tin (cash)	139 10 0
,, (three months)	142 5 0
Copper (cash)	37 17 6
,, (three months)	37 6 3
Spanish Lead (cash)	14 18 9
,, ,, (three months)	14 18 9
Spelter (cash)	14 7 6
,, (three months)	14 15 0
MANCHESTER—	
Copper, Best Selected Ingots	42 0 0
,, Electrolytic	44 0 0
,, Strong Sheets	72 0 0
,, Tubes (Basis Price), lb.	0 0 11
Brass Tubes (Basis Price), lb.	0 0 9½
,, Condenser, lb.	0 1 0
Lead, English	17 0 0
,, Foreign	15 5 0
Spelter	15 0 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/4 per lb.	
Ferro Tungsten	2/– per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 12 6	7/–
,, ,, 6 p.c. to 8 p.c.	£23 10 0	7/–
,, ,, 8 p.c. to 10 p.c.	£22 15 0	6/6
,, ,, Specially Refined		
,, ,, Max. 2 p.c. carbon	£36 10 0	10/–
,, ,, ,, 1 p.c. carbon	£43 10 0	12 –
,, ,, ,, 0·70 p.c. carbon	£52 10 0	13/–
,, ,, ,, carbon free	11d. per lb.	
Metallic Chromium	3/1 per lb.	
Ferro Manganese (per ton)	£11 0 0 for home	
,, ,, ,,	£11 10 0 for export	
,, Silicon, 45 p.c. to 50 p.c.	£9 15 0 unit	scale 5/– per
,, ,, 75 p.c.	£15 10 0 unit	scale 7/– per
,, Vanadium	12/9 per lb.	
,, Molybdenum	6/3 per lb.	
,, Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£250 to £255	
Ferro Cobalt	10/– per lb.	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	13/– to 13/3
,, ,, Ell	14/3
,, ,, Splint	14/– to 16/–
,, ,, Trebles	12/6
,, ,, Doubles	10/9
,, ,, Singles	9/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/–
,, ,, Jewel	17/–
,, ,, Trebles	12/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	12/– to 12/9
Screened Navigation	16/6
Trebles	12/6
Doubles	10/9
Singles	9/6
LOTHIANS—	
(f.o.b. Leith)—Best Steam	12/–
Secondary Steam	11/9
Trebles	12/9
Doubles	10/9
Singles	9/6

(8) N.W. COAST— ENGLAND.

Steams	21/9
Household	32/6 to 51/6
Coke	20/6 to 22/6
NORTHUMBERLAND—	
Best Steams	13/9
Second Steams	12/3 to 12/6
Steam Smalls	8/6 to 9/–
Unscreened	12/6 to 13/–
Household	27/– to 39/–
DURHAM—	
Best Gas	14/6
Second	13/6
Household	25/– to 37/–
Foundry Coke	24/–
SHEFFIELD—	Inland.
Best Hand-picked Branch	26/6 to 27/6 —
South Yorkshire Best	22/– to 23/– —
Derbyshire Best Bright House	19/– to 20/6 —
Best House Coal	22/– to 23/– —
Screened House Coal	19/– to 20/6 —
Best Screened Nuts	17/– to 18/– —
Small Screened Nuts	14/6 to 15/6 —
Yorkshire Hards	16/– to 18/– —
Derbyshire Hards	16/– to 18/– —
Rough Slacks	8/6 to 9/6 —
Nutty Slacks	7/– to 8/6 —
Smalls	5/– to 6/– —
Blast-furnace Coke (Inland)	12/– to 12/6 on rail at ovens
Furnace and Foundry Coke (Export), f.o.b.,	18/– to 18/6

(9) SOUTH WALES.

CARDIFF—	
Steam Coals :	
Best Smokeless Large	19/6 to 19/9
Second Smokeless Large	18/9 to 19/6
Best Dry Large	19/– to 19/6
Ordinary Dry Large	17/9 to 18/3
Best Black Vein Large	18/3 to 18/6
Western Valley Large	17/9 to 18/–
Best Eastern Valley Large	17/7½ to 17/9
Ordinary Eastern Valley Large	17/3 to 17/6
Best Steam Smalls	13/– to 13/6
Ordinary Smalls	11/– to 13/–
Washed Nuts	19/– to 25/–
No. 3 Rhondda Large	19/9 to 20/–
,, ,, Smalls	15/– to 16/–
No. 2 ,, Large	17/– to 17/3
,, ,, Through	15/6 to 16/–
,, ,, Smalls	14/– to 14/3
Foundry Coke (Export)	22/6 to 36/6
Furnace Coke (Export)	17/– to 18/–
Patent Fuel	19/– to 19/3
Pitwood (ex ship)	21/6 to 24/–
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	36/– to 38/6
Seconds	27/– to 32/6
Red Vein	22/6 to 27/6
Machine-made Cobbles	41/6 to 43/6
Nuts	40/– to 42/6
Beans	29/6 to 32/6
Peas	18/– to 21/–
Breaker Duff	8/6 to 9/6
Rubbly Culm	8/3 to 8/9
Steam Coals :	
Large	20/– to 20/6
Seconds	18/– to 20/–
Smalls	11/6 to 13/–
Cargo Through	16/– to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham. (d) Rebate; Joists (minimum), 22/6; Ordinary Ship, Bridge, and Tank Plates and Sections, 15/– if home consumers confine purchases from associated British Steel Makers. (e) Delivered Black Country Stations.

French Engineering Notes.

(From our own Correspondent in Paris.)

Metallurgical Trades.

THE decline in the quotations for semi-manufactured steel and joists on the Brussels Exchange and a continued contraction of business on the French market, coupled with the failure to reconstitute the Steel Cartel and to organise the international sales comptoir, have left the steel trade in a very despondent condition. The import duty of 10 per cent. into Great Britain, added to the burden of the sterling depreciation, is believed to have cut out foreign steel products, and in France the opinion is general that, having exhausted their efforts to organise continental trade, the French must now look to Great Britain as the pivot on which all future negotiations must turn. They are particularly concerned at the standing menace of a 100 per cent. import duty on products from countries which discriminate against Great Britain. They endeavour to explain that the 15 per cent. super-tax against countries going off the gold standard is not discrimination, but the fact remains that it only materially affects Great Britain, since the other countries that have left gold do little business with France. The super-tax was inopportune because Britain is the only country the commercial exchanges of which left a good balance in favour of France. The whole situation must therefore now be radically changed. It can only be done by an agreement with Great Britain, which, it is hoped, will constitute the basis of a general trade organisation, and, in view of the Ottawa Conference, the French are anxious to lay down the principles of an agreement which would not be nullified by Imperial preference. It is understood that preliminary negotiations are now in progress for a commercial *entente* between the two countries, and the French hope that, after the Ottawa Conference, a new commercial policy, which would have the effect of considerably improving the industrial and trade outlook, will be initiated.

Vals de Loire Water Supply.

When, before the war, the idea of bringing a million cubic metres of water a day from the Vals de Loire to Paris was revived, it was proposed to sink wells through the sandy bed of the valley and to pump water to the city. That method has since been modified by Monsieur Santenac, Chief Engineer of the Paris Water Department, who found that the difference of level between the source of supply and Paris was sufficient to allow of the water being sent by gravitation. The water is to be obtained from a natural filtering bed between Gien and Nevers, which has a length of 43 miles and a width of more than half a mile, and which collects water from the river Loire and from the sides of the valley. The water, filtered through a homogeneous layer of sand from 8 m. to 10 m. thick, is remarkably pure and soft. The method now proposed of collecting the water is to lay a main 3·5 m. diameter at the bottom of the sandy stratum along the valley for a distance of about 40 miles, with sufficient inclination and with feeder mains branching off on either side. The end of the collector main will be connected with an aqueduct 90 miles long and 4·5 m. diameter for delivery by gravitation to Paris.

The Trans-Saharan Railway.

The efforts of the Académie des Sciences Coloniales, which organises research work in the Colonies, are now centred more particularly in the Sahara desert, where a methodic survey is being made with a view to utilising any resources that may be available in that region by irrigation and other means. The construction of the Trans-Saharan Railway is regarded as having become indispensable now that the closing of foreign markets has compelled this country to turn its attention to the Colonies, and powerful influences are being brought to bear upon the Government to introduce the Bill that is declared to be already assured of the support of a majority in the Chamber of Deputies. Of immediate importance is the argument that the construction of the railway will help to relieve the country of the economic crisis through which it is passing. According to new plans that have been submitted to the Government, two years will be occupied in preliminary works and in the construction of a bridge 350 m. long across the Guir, and when that is done the railway is to be laid down at the rate of a mile a day, so that the whole work should be completed within a period of eight years. The possibility of constructing the railway and running it with oil-electric locomotives is not questioned, but there is a good deal of doubt about its commercial value, while the financial situation at present is not favourable to the raising of funds for the purpose.

Motor Car Trade.

Following upon the last Motor Car Show in Paris, one of the largest manufacturers made a substantial cut in prices in the hope that an increased demand for cars would bring the production up to a normal level. Other makers had to follow his example. The results have not come up to expectations, for the reason that, while the export trade has rapidly declined, the home market is suffering from the economic depression, and lower prices have failed to stimulate the demand sufficiently to justify the reduction. The maker who initiated it has therefore announced his intention of returning to the previous price level. The situation has become precarious for those who engaged in the mass production of cars at a time when foreign markets were open to them. Those markets are now closed, and the home demand is insufficient to absorb what can be produced. The industry is therefore entering upon a new phase in which a great deal of research work is being carried out in the way of adapting engines to run on cheaper fuels. Last week Monsieur Charles Roux started with two lorries on a Government mission to Africa. He proposes to cross the Sahara desert and travel through French West Africa, where he will run the cars on locally produced vegetable oils.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

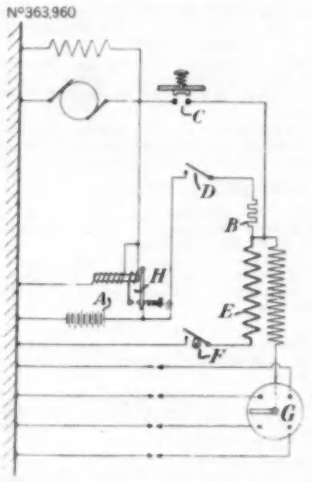
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

363,960. June 11th, 1931.—IGNITION SYSTEMS FOR INTERNAL COMBUSTION ENGINES, Robert Bosch Aktiengesellschaft, of 4, Militärstrasse, Stuttgart, Germany.

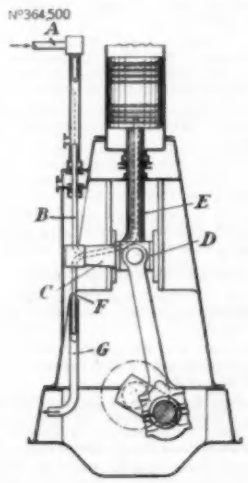
The object of this invention is to prevent the primary of a spark ignition coil being unintentionally left in circuit at full battery or dynamo voltage for a long time without the series resistance. When, for any reason, the battery is unable to supply any current, the dynamo can be made to rotate in the case of a motor cycle, for example, by turning the wheel, when the dynamo will rotate at sufficient speed to cause ignition, it being



assumed that the series resistance is bridged over by the press-button switch C, which is released after ignition has occurred, and the dynamo has attained its normal speed. When this condition has been established the automatic switch H is switched in and the dynamo current can flow through the series switch D to the coil E, the switch C being open. It will be seen that with this arrangement the primary coil can never be unintentionally connected across the dynamo and battery for a long period without the series resistance. F is, of course, the mechanical contact breaker and G the distributor.—*December 31st*, 1931.

364,500. June 4th, 1931.—COOLING PISTONS, Sulzer Frères Société Anonyme, Winterthur, Switzerland.

The cooling water is supplied through a pipe A and injected in the form of a jet in a downward direction towards the receiving orifice of a pipe B carried by an arm C formed integral with or secured to the crosshead D. Water entering the pipe B as it reciprocates with the crosshead D, passes up the hollow piston-rod E to the interior of the piston, when it is discharged

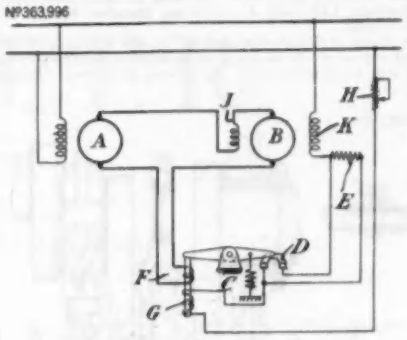


through the telescopically arranged pipes F and G. In this way, since the jet is downwardly directed, the tendency for the column of water constituting the jet is to be dispersed into spray when the receiving pipe moves in the opposite direction to that of the jet is reduced, and, in addition, the water in the column will not tend to flow back under the action of gravity towards the injection nozzle and thereby tend to disperse the jet as is the case when an upwardly directed jet is employed.—*January 7th*, 1932.

DYNAMOS AND MOTORS.

363,996. September 24th, 1930.—ELECTRIC MOTOR CONTROL SYSTEMS, Eric Maurice Johnson, of 33, Poplar-grove, Brooklands, Chester, and Associated Electrical Industries, Ltd., of Crown House, Aldwych, Westminster.

In accordance with this invention the speed of a motor A is governed when starting up, for instance, by rheostatic field or exciter control of the generator B. The motor current is automatically limited by a relay, which by means of a short-circuit bridge D inserts a limiting resistance E in the generator field circuit when the current tends to become excessive. It will be seen that the relay has two coils F and G, connected as shown in the diagram, H being a variable resistance. The coil G serves to bias the relay and exerts a force in opposition to the coil F. The winding J is a reverse series compounding

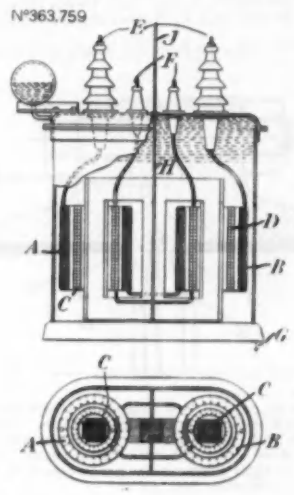


winding, while the winding K is a shunt winding.—*December 24th*, 1931.

TRANSFORMERS AND CONVERTERS.

363,759. October 18th, 1930.—TRANSFORMERS, *The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C. 2.*

The transformer described in this specification is intended for use on large three-phase systems employing single-phase units. In each of these transformers there is a core of the type shown. The H.T. winding is composed of two sections, A and B, whilst the low-voltage winding is composed of sections C and D.

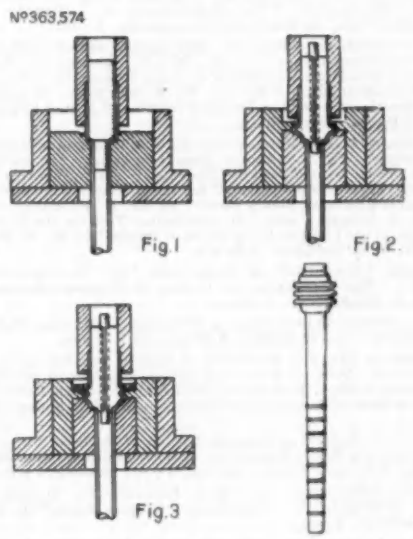


Like the H.T. winding sections, these secondary sections are connected in series. The H.T. winding is connected to the terminals E and the low-tension terminals to the winding F. The case is connected to earth at G, and the casing is connected to the core. In order to extend the isolation principle still further, an earthed metallic barrier H may be provided between the leads from the high-voltage windings to the terminal E. A barrier J may also be provided between the terminals.—*December 31st*, 1931.

MISCELLANEOUS.

363,574. March 21st, 1931.—MAKING CIRCUMFERENTIAL CORRUGATIONS ON HOLLOW METAL SPOOLS, R. Hardmeyer, Künsnacht, near Zürich, Switzerland.

This invention is concerned with the production of hollow metal spools, for the textile industry, which are provided with corrugations as shown in the sketch. These corrugations are formed by upsetting the tube by end pressure. The first corru-

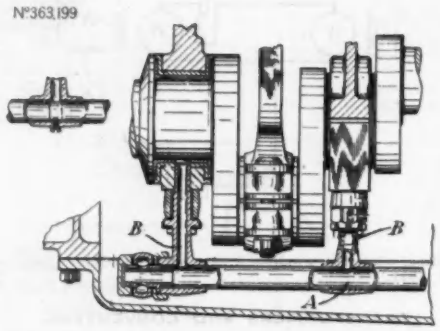


gation is formed as shown in Fig. 1, where the shoulder is supported on a die and the upper end of the tube is pressed down so that the metal swells out into recesses in the dies. A split die is then inserted in the tube to support the interior of the corrugation—see Fig. 2—and a split die inserted beneath the shoulder. Another die surrounds the first corrugation and provides for the formation of the second corrugation. A new

mandrel with two ridges is then inserted—see Fig. 3. A ring is then placed on the top of the die and the third corrugation formed.—*December 24th*, 1931.

363,199. January 29th, 1931.—ENGINE LUBRICATION SYSTEMS, Humber, Ltd., and J. S. Irving, Humber Works, Stoke, Coventry.

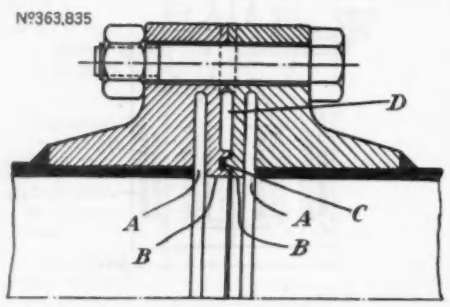
The object of this invention is to provide a system of forced-feed lubrication to the bearings of an internal combustion engine which will be immune from the effects of thermal expansion.



The oil supply is provided by the pipe A, and is delivered to the bearings by the branches B B. These branches are connected with the main supply pipe by T pieces, which are a sliding fit, and are made reasonably oil-tight by labyrinth packings, so that longitudinal expansion may be accommodated. Vertical expansion is also taken care of by a sliding joint in the bearing cap.—*December 17th*, 1931.

363,835. December 23rd, 1930.—PIPE JOINTS, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C. 2, and F. Samuelson, 44, Hillmorton-road, Rugby.

The flanges of this pipe joint are deeply grooved, as shown



at A A, so as to provide two webs B B, which are spigotted together, with a sealing ring C between them. The space D communicates with the atmosphere. When the bolts are tightened up there is a slight initial deformation of the webs, that ensures a tight joint which is maintained by the steam pressure itself.—*December 31st*, 1931.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Tuesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

ILLUMINATING ENGINEERING SOCIETY.—At the House of the Royal Society of Arts, John-street, Adelphi, W.C. 2. Discussion on "Lighting of Churches and Cathedrals." 7.15 p.m.

INSTITUTE OF FUEL.—At the Engineers' Club, 17, Albert-square, Manchester. "The Maintenance of Uniformity in Industrial Fuels," by Dr. A. C. Dunningham. 7 p.m.

INSTITUTION OF CHEMICAL ENGINEERS.—Hotel Victoria, Northumberland-avenue, London, W.C. 2. Annual Corporate Meeting; Presentation of Medals, 11 a.m.; Presidential Address, "Control of Industry," by Mr. W. A. S. Calder, 12 noon; "Thermal Insulation," by Dr. Ezer Griffiths, F.R.S., 2.15 p.m.; Annual Dinner, 7 for 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, S.W. 1. Annual general meeting. The annual report of the Council will be presented; annual election of Council. Papers for discussion, "Testing of Materials for Service in High-temperature Steam Plant," by Mr. R. W. Bailey and Mr. A. M. Roberts; and "An Accelerated Test for the Determination of the Limiting Creep Stress of Metals," by Mr. W. Barr and Mr. W. E. Bardgett. 5.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "The Ventilation and Cooling of Turbo-alternators," by Mr. D. MacFarlane. 7.30 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS.—Midland Hotel, Manchester. Annual dinner. 6.45 p.m. for 7.15 p.m.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.—Visit to Armstrong College Engineering Society, Armstrong College, Newcastle-upon-Tyne. "Modern Developments in Electric Welding Application," by Mr. E. P. S. Gardner. 7 p.m.

PHYSICAL SOCIETY.—Imperial College of Science, Imperial Institute-road, South Kensington, S.W. 7. Editing Committee meeting, 3.30 p.m.; Council meeting, 4 p.m.; meeting, 5 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Discourse, "Shifting Sands," by Mr. C. F. Jenkin. 9 p.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE.—In the "Societies' Room," No. 24, Royal Technical College, George-street, Glasgow. "Progress in Steel Metallurgy as Regards Resistance to Corrosion," by Dr. W. H. Hatfield. 7.15 p.m.

SATURDAY, FEBRUARY 20TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Joint meeting of the North-Western and Yorkshire Districts at Sheffield. Grand Hotel Sheffield. Luncheon, 1 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS: SOUTH-EASTERN DISTRICT MEETING.—Assemble at Vestry Hall, London-road, Mitcham. 11.30 a.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—South Wales District meeting at Cardiff. Assemble City Hall, Cardiff, 2.15 p.m.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.—Newcastle-upon-Tyne. Discussion: "A Method of Preventing Crush to Brick Stoppings and Similar Structures," by Mr. C. H. Leeds; "Stowage of the Goaf," by Professor Granville Poole and Mr. J. T. Whetton. In connection with this discussion Mr. Jenkins, of the Mining Engineering Company, Ltd., will exhibit and describe their new stowing jet. Paper, "Early Steam Engines in the North of England," by Professor Henry Louis. 2.30 p.m.

MONDAY, FEBRUARY 22ND.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W. 1. Graduates' Section. "Potential Applications of Pulverised Fuels," by Mr. H. Heywood. 6.45 p.m.

MONDAY TO SATURDAY, FEBRUARY 22ND TO MARCH 5TH.

BRITISH INDUSTRIES FAIR, 1932.—Castle Bromwich, Birmingham, to March 4th, 1932; Olympia, London, to March 3rd, 1932; White City, to March 5th, 1932.

TUESDAY, FEBRUARY 23RD.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Discussion, "The Pressure on Retaining Walls," by Mr. C. F. Jenkin. 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH MIDLAND CENTRE.—At the Hotel Metropole, Leeds. "Short-duration Temperature Testing of Electrical Machines," by Mr. W. E. French. 7 p.m.

SHEFFIELD METALLURGICAL ASSOCIATION.—198, West-street, Sheffield. "Material Requirements in Aircraft Structure, with Special Reference to Steel," by Mr. H. J. Pollard. 7.30 p.m.

WEDNESDAY, FEBRUARY 24TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Engineers' Club, Albert-square, Manchester. "The Possibilities of the Unorthodox," by Mr. Maurice Platt. 7 p.m.

INSTITUTION OF CIVIL ENGINEERS: STUDENTS' MEETING.—Great George street, Westminster, S.W. 1. "Practical Observations on the Construction of a Concrete Road," by Mr. R. R. W. Gregson. 6.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C. 2. Wireless Section meeting. Discussion on "Selectivity," opened by Professor C. L. Fortescue. 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: LONDON STUDENTS' SECTION.—Visit to Venner Time Switches, Ltd., Raynes Park, 3 p.m. Annual Dinner at the Florence Restaurant, Rupert-street, W. 1. 7.15 for 7.30 p.m.

INSTITUTION OF WELDING ENGINEERS.—At the Institution of Mechanical Engineers, Storey's-gate, St. James's Park, London, S.W. 1. The name of the winner of the Operative Welders' Prize Competition, 1931, will be declared, followed by the awarding of the Prize and Gold Medal to the winner and a Silver Medal and Certificates to those whose papers are highly commended. The winner will then read his paper "Welding and Cutting on Railways and Tramways," which will be illustrated by lantern slides. 7.45 p.m.

SOCIETY OF GLASS TECHNOLOGY.—Joint Meeting with the Ceramic Society, Sheffield. Visit to Department of Refractory Materials, St. George's-square. 9.15 to 10.45 a.m. In the Applied Science Department, The University, St. George's-square, Sheffield. "The Strength of Materials as Affected by Discontinuities and Surface Conditions," by Professor F. C. Lea; "The Tensile Strength of Glass," by Mr. E. J. Gooding; 11 a.m. "The Crystal Structure of Sillimanite and Related Materials," by Dr. W. H. Taylor; "Studies of Clay Mixtures for Glass Melting Pots: Part IV., The Corrosion-resisting Properties," by Dr. J. H. Partridge, Mr. G. F. Adams and Mr. J. R. Lait; 2.30 p.m.

THURSDAY, FEBRUARY 25TH.

ENGINEERING GOLFING SOCIETY.—At the Institution of Mechanical Engineers, Storey's-gate, Westminster. Annual General Meeting. 12.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C. 2. "Metal-clad Switchgear, Automatic Protection, and Remote Control, with Special Reference to Developments during the Last Seven Years." 6 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS: SOUTHERN DISTRICT MEETING.—Assemble at Guildhall, Abingdon, at 11 a.m.

INSTITUTION OF STRUCTURAL ENGINEERS.—10, Upper Belgrave-street, S.W. 1. "Modern Development in Surface Treatment," by Mr. Hugh Davies. 6.30 p.m.

ROYAL AERONAUTICAL SOCIETY.—In the Royal Society of Arts, John-street, Adelphi, W.C. 2. "Catapults and the Catapulting of Aeroplanes," by Mr. P. Salmon. 6.30 p.m.

FRIDAY, FEBRUARY 26TH.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—Trocadero Restaurant, Shaftesbury-avenue, London, W. 1. Annual Dinner. 6.30 for 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "Recent Applications of the Ternary Alloys of Lead," by Mr. Kenneth Gray. 7.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—In the Lecture Theatre of the Mining Institute, Newcastle-upon-Tyne. "Combustion in Heavy Oil Engines," by Mr. L. J. Le Mesurier and Mr. R. Stansfield. 6 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, W. 1. Discourse, "Uncertainty Principle in Modern Physics," by Mr. C. G. Darwin. 9 p.m.

SATURDAY, FEBRUARY 27TH.

INSTITUTION OF ELECTRICAL ENGINEERS: SOUTH MIDLAND STUDENTS' SECTION.—Visit to the British Industries Fair at Castle Bromwich. Tea in Royal Room. 4.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. "The Electron," by Lord Rutherford. 3 p.m.

MONDAY, FEBRUARY 29TH.

ENGINEERS' GERMAN CIRCLE (DEUTSCHER INGENIEURZIRKEL).—At the Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. "Leistungen der deutschen Technik 1931" ("German Technical Accomplishments in 1931"). Illustrated with lantern slides, by Herr Oberingenieur Carl Derschow. 6 p.m.

INSTITUTE OF METALS.—Official visit to British Industries Fair, Castle Bromwich, Birmingham.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. Discussion on "The Standardisation of the Frequency of Electricity Supply in Paris," opened by Mr. P. Rieunier, who will exhibit a cinematograph film. Joint meeting with the British Section of the Société des Ingénieurs Civils de France. 7.15 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS: BIRMINGHAM CENTRE.—Room 178, Queen's Hotel, Birmingham. "The Effect of Commercial Efficiency on Locomotive Design," by Mr. R. G. McLaughlin. 6.45 p.m.

TUESDAY, MARCH 1ST.

CHEMICAL ENGINEERING GROUP.—Caxton Hall, Westminster, S.W. 1. "Some Problems Connected with High-speed Compression-ignition Engine Developments," by Mr. C. B. Dicksee Joint General Meeting with ten other societies. 7.45 p.m.

WEDNESDAY, MARCH 2ND.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Queen's Hotel, Birmingham. "The Possibilities of the Unorthodox," by Mr. Maurice Platt. 7.30 p.m.

NEWCOMEN SOCIETY.—At the British Industries Fair, Castle Bromwich, in the New Committee Room, near the Royal Room, extreme east of building. "The Early History of the Magnet," by Dr. J. B. Kramer. 4.30 p.m.

THURSDAY, MARCH 3RD.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—In the Chamber of Commerce, New-street, Birmingham. "Gases in Metals," by Mr. S. L. Archbutt. 7 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS: MIDLAND DISTRICT.—Visit to British Industries Fair, Castle Bromwich. Lunch in the Royal Room, 1 p.m.

FRIDAY, MARCH 4TH.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—In the Non-ferrous Section of the Applied Science Department of the University, St. George's-square, Sheffield. Conjoint meeting with Sheffield Technical Trades Society. "Defects in Spoon and Fork Blanks," by Mr. W. R. Barclay. 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W. 1. Informal meeting. Discussion, "Industrial and Commercial Waste," to be introduced by Mr. J. L. Hodgson. 7 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS: NORTH-WESTERN DISTRICT.—Visit to Irlam Works of the Lancashire Steel Corporation, Ltd., Irlam, near Manchester. Assemble at works 12.15 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "The Preparation of Commercial Copper from its Ores," by Mr. T. J. Taplin. 7.30 p.m.

MONDAY, MARCH 7TH.

WOLVERHAMPTON AND DISTRICT ENGINEERING SOCIETY.—The Victoria Hotel, Wolverhampton. "Steam Generation in Factories," by Mr. H. E. Partridge. 7.30 p.m.

TUESDAY, MARCH 8TH.

INSTITUTE OF METALS: SWANSEA LOCAL SECTION.—At the Y.M.C.A., Swansea. "Metallography in Industry," by Mr. Roosevelt Griffiths. Also annual general meeting. 6.15 p.m.

WEDNESDAY, MARCH 9TH.

INSTITUTE OF METALS.—Trocadero Restaurant, Piccadilly-circus, W. 1. Annual dinner and dance. 7 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "Afforestation Work in the Central Plateau of France, with Some Notes on the Work Undertaken at the Military Camp of La Courtine," by Mr. Edward P. Stebbing. 8 p.m.

WEDNESDAY AND THURSDAY, MARCH 9TH AND 10TH.

INSTITUTE OF METALS.—In the Hall of the Institution of Mechanical Engineers, Storey's-gate, S.W. 1. Twenty-fourth annual general meeting. Reading and discussion of papers. For programme see page 137.

THURSDAY, MARCH 10TH.

STEPHENSON LOCOMOTIVE SOCIETY.—At Headquarters, King's Cross. "Some Factors Affecting the Riding of Coaching Stock," by Mr. A. J. Dymond. 6.30 p.m.

FRIDAY, MARCH 11TH.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH MIDLAND CENTRE.—Hotel Metropole, Leeds. Annual dinner. 7 p.m. for 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "The Manufacture of Large Astronomical Telescopes," by Mr. Cyril Young. 7.30 p.m.

SATURDAY, MARCH 12TH.

FINSBURY TECHNICAL COLLEGE OLD STUDENTS' ASSOCIATION.—At the Trocadero Restaurant, London, W. 1. Annual dinner. Particulars and tickets may be obtained from Mr. F. R. C. Rouse, 15, Clifton-gardens, Golders Green, N.W. 11.

MONDAY, MARCH 14TH.

INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—In the Rooms of the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. "Some Notes on Condenser Tubes and their Packing," by Mr. J. Stirling; "Non-ferrous Alloys in Marine Engineering: Some Recent Developments," by Dr. J. W. Donaldson. Also annual general meeting. 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W. 1. Graduates' Section. Annual Lecture, "The Strength and Behaviour of Steels at High Temperatures," by Dr. W. H. Hatfield. 6.45 p.m.

TUESDAY, MARCH 15TH.

INSTITUTE OF METALS: NORTH-EAST COAST LOCAL SECTION.—In the Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. "Refining of Copper," by Mr. R. D. Burn. Also annual general meeting. 7.30 p.m.

WEDNESDAY, MARCH 16TH.

INSTITUTION OF NAVAL ARCHITECTS.—Grand Hall, Connaught Rooms, Great Queen-street, Kingsway, London, W.C. 2. Annual Dinner. 7.30 p.m.

WEDNESDAY TO FRIDAY, MARCH 16TH, 17TH AND 18TH.

INSTITUTION OF NAVAL ARCHITECTS.—In the Lecture Hall, Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Seventy-third Annual Meeting.

THURSDAY, MARCH 17TH.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—In the Chamber of Commerce, New-street, Birmingham. "The Extrusion of Metals," by Mr. R. Genders. 7 p.m.

INSTITUTE OF METALS: LONDON LOCAL SECTION.—In the Rooms of the Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W. 1. "The Efficacy of Testing Methods," by Dr. H. J. Gough. 7.30 p.m.

By arrangement with Reuter's Engineering Service, THE ENGINEER *contains the latest news from all parts of the world which is likely to be of interest to engineers.*